DALLAS, TEXAS SEPTEMBER, 1932

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The Engineering Magazine of the Oil and Gas Industry

Edited and Circulated Only for those Actively Engaged in the Operating Departments of the Industry

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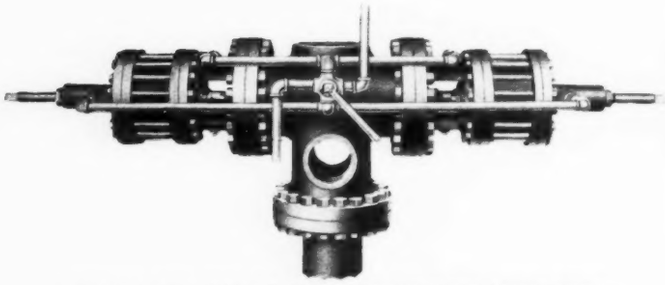

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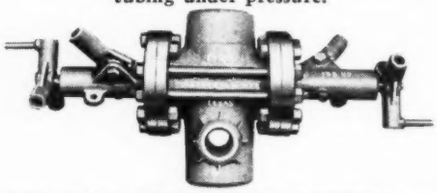

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The Month's HIGH LIGHTS in OILDOM

By J. L. DWYER

TEXAS, which for some time has dominated the oil activity of the nation, this month was the scene of several actions which have clouded oil's industrial horizon.

Early in the month, the Texas Railroad Commission increased the daily allowable production per well of the East Texas field from 43 to 50 barrels, and opinion among operators as to the wisdom of this action has been sharply decided. The crude oil purchasing companies naturally have also indicated a varying opinion on the subject; one group headed by H. F. Sinclair, chairman of the board of directors of the Consolidated Oil Corp., assuming the position that the increase was entirely justified, and that the market structure would suffer no damage as a result. The other faction, led by the Empire Oil & Refining Co., apparently disapproved of the procedure and declined to purchase more than 43 barrels per well per day from the East Texas field.

The matter was simmering quietly when the Humble Oil & Refining Co. announced that on and after September 12, it would purchase only 25 barrels daily from each well to which it was connected, and that it would run from the lease tanks an additional 25 barrels daily, the latter crude to be stored in tanks of the Humble and the producer owning the oil to be charged a storage fee of two cents a barrel monthly. Immediately upon the announcement of this, Attorney General Allred of Texas filed an injunction suit against the Humble in which it was restrained from placing its order into effect. The injunction specified that the companies must purchase oil ratably from all wells in the field, and also prohibits the pipe line company from disconnecting any wells to which it is now connected. As this is written (September 12) the outcome of the matter is unsettled.

It seems very likely that the net result of the entire performance will be a downward revision of the crude oil price in Texas and the rest of the Mid-Continent region.

Rumors of East Texas crude being offered below the posted price have long been current, and the amounts reported varied greatly. The concensus of opinion indicates that while there is every possibility of this oil being offered below the market price, the oil thus sold will not exceed 25,000 barrels daily.

The mechanical situation in East Texas shows a slight change. At this time on an average of two wells daily are being rigged up to be put on the pump; this is a slight increase from last month, and in all probability the number of pumping wells will continue to show an increase each month during the winter.

In California, the oil industry is facing the problem incidental to decreased consumption during winter by trying to place its house in order. The present suggested figure of 476,000 barrels of oil production per day for the state is believed to be approximately 40,000 barrels above the amount which the Pacific Coast market can assimilate, and it is believed that something close to this figure will be adopted as the state's allowable for the winter months.

Production and Refining Figures Furnished by the American Petroleum Institute

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending August 27, 1932

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel	Gas and Fuel Oil Stocks
East Coast	100.0	443,900	70.0	17,160	9,043
Appalachian	91.8	89,600	65.2	2,073	1,011
Ind., Ill., Ky.	98.9	277,000	64.2	7,592	4,358
Okla., Kans., Mo.	89.6	230,900	53.1	4,856	3,483
Inland Texas	76.5	95,100	40.7	1,539	2,120
Texas Gulf	99.8	362,400	68.2	4,689	9,767
Louisiana Gulf	100.0	96,300	65.3	1,744	4.242
No. Louisiana-Ark.	97.0	42,400	51.1	213	627
Rocky Mountain	89.4	45,400	31.6	1,768	537
California	96.7	421,100	47.6	15,210	99,737
Total Aug. 27, 1932	95.1	2,104,100	57.5	56,844	134,925
Total Aug., 1932	95.1	2,128,300	58.1	57,974	134,100

Daily Average Production

(Figures in Barrels)

	Week Ended Aug. 27, 1932	Week Ended July 23, 1932	Week Ended Aug. 29, 1931
Oklahoma	387,150	454,450	*265,850
Kansas	95,250	96,550	99,550
Panhandle Texas	53,650	53,850	59,000
North Texas	49,800	49,600	55,150
West Central Texas	24,700	24,550	23,150
West Texas	172,750	177,500	206,050
East Central Texas	56,800	57,550	53,950
East Texas	327,700	345,500	*
Southwest Texas	53,850	56,000	58,750
North Louisiana	29,300	29,900	29,650
Arkansas	34,100	34,150	37,300
Coastal Texas	123,500	116,900	129,000
Coastal Louisiana	32,300	32,450	23,500
Eastern (not including Mich.)	101,000	103,600	101,750
Michigan	22,650	18,850	9,900
Wyoming	33,350	35,900	38,000
Montana	7,450	7,700	7,900
Colorado	2,750	2,850	4,000
New Mexico	31,550	36,100	43,300
California	474,400	471,900	505,800
TOTAL	2,114,000	2,205,850	1,751,550

* Martial law in effect in Oklahoma and East Texas.

NOTE: Stocks at refineries, except in California district, which includes stocks on finished gasoline and engine distillate at refineries, water terminals and sales distributing stations and amounts in transit thereto.

Increase East Texas Allowable to 50 Barrels

The Texas Railroad Commission has fixed the per well daily allowable flow for the East Texas oil field at fifty barrels, effective September 1st. This order replaced one permitting a flow of 43 barrels per well daily. The new order provides that the field shall operate under a top allowable of 375,000 barrels daily, whereas the old order limited maximum production to 325,000 barrels per day.

The new order of fifty barrels per well daily will hold until September 15th, at which time an adjusted allowable will be established for the next fifteen days.

Beaty Sees East Texas Increase as Dangerous

Amos L. Beaty, president of the American Petroleum Institute, issued a statement saying the increase in the well allowable in East Texas was a danger to oil stability.

Beaty stated that there was no market for additional East Texas oil and that with the seasonal decline in consumption beginning the first of September, together with the depression decline of 1932, the increased outlet would be a burden on the oil market.

Tank Car Shipments from East Texas Increasing

With pipe line companies taking on only the necessary connections because of being amply supplied with crude oil, shipments of crude by tank cars from the East Texas field are increasing. During the past several weeks approximately 10,000 barrels daily have been accounted for, and rumors are that much additional oil has been moved. In many instances it is understood shipments have been sold at prices below the present posted schedule.

Most of the oil leaving the field by tank cars are shipped to refining points in Texas, Louisiana and Canada. The gradual increasing amount of oil obtainable at prices below the market is an alarming condition confronting operators in the field at the present time. In the majority of instances offers of this kind have been made by owners unable to secure connections to their wells.

States Organizing to Combat Gasoline Tax Evasion

Realization by oil men everywhere that evasion of gasoline tax by gasoline bootleggers is a very serious problem is leading to the taking of steps in many areas to combat the evil. In some quarters, for instance Alabama, a report on the government of the state by the Brookings Institution, Washington, urges that the power to levy a gasoline tax be confined to the state government, and that counties and cities be no longer permitted to make such levies. The Brookings report states that pyramiding of gasoline taxes has pushed the rates up beyond the limit of maximum effectiveness, and which will not permit the continued development of country highway systems.

North Carolina is the latest state to take organized steps to combat evasion. Oil marketers in the state have organized the North Carolina Petroleum Industries Committee with the major immediate objective of co-operating with state officials in suppressing gasoline bootlegging and gasoline tax evasion.

In Texas, there is a movement started to secure tax relief. Efforts are being devoted to secure changes in existing laws dealing with gasoline taxation and specifications and a lowering of the present four-cent per gallon state tax. It is estimated that tax evasion is robbing the state of nearly two million dollars annually. It is believed the state's revenue from gasoline taxes would not decline with a lower tax, due to the reporting of additional gallonage.

Propose Tax on Natural Gas

A bill has been introduced at the special session of the Alabama legislature to levy a tax of two cents per 1,000 feet on natural gas consumption.

Sinclair Does Not Believe East Texas Will Upset Market

Although many oil men are frank to admit they fear the seven barrel per well per day increase in the allowable outlet of the East Texas field might tend to bring about a reduction in the posted market price for oil, Harry F. Sinclair, chairman of the executive committee of Consolidated Oil Corporation, is of the opinion that the allowable of 50 barrels daily to the well should not be permitted to upset the market.

Crude Purchasers Adhering to New Allowable

Although first indications were that the majority of purchasers in East Texas would continue to take 43 barrels per day from each well instead of adhering to the new Railroad Commission allowable of 50 barrels daily it now appears that the pipe line companies will do as the Railroad Commission desires.

The Magnolia Petroleum Company, Gulf Pipe Line Company and Sinclair-Prairie Crude Oil Marketing Company have announced that they will purchase 50 barrels daily from wells to which they are connectd. The producing departments of these companies also plan to produce their wells at the rate of 50 barrels daily.

Canadian Refinery Capacity Increasing

The erection and contemplated construction of a number of refineries in Canada is greatly increasing this country's refining capacity, which used 29,000,000 barrels of crude oil in 1930.

Among plants now under construction are the following: Shell Oil Company of Canada building two refineries at Montreal and Vancouver; LaSalle Petroleum at Montreal; Quaker State Oil Refining Company, blending plant at Toronto; Hi-Way Refineries of Regina at Saskatoon, Sask.; Northwest Stellarene Company, enlargement of its plant at Coutts, Alberta; and Lion Refining Company at plant at Calgary, making the fourth plant in that city.

New Mexico Losing Heavily on Gasoline Tax

Gasoline bootlegging is costing the State of New Mexico $500,000 a year in taxes, according to Senator Tom Hughes of Albuquerque, who has proposed a special session of the legislature to enact stricter laws.

He would amend the present law to eliminate the 30-day allowable truckers to report sales and would strike from the present bill a clause providing a specific gravity of 46. The Senator charges that about 1,000,000 gallons of gasoline per month is escaping the 5-cent per gallon tax.

East Texas Fairly Well Drilled Up; Drilling Operations are Declining

Recent figures show that the East Texas field with 113,904 acres and 7600 producers has an average of one well to every fifteen acres, showing that the pool is fairly well drilled up. At the same time there are no important undeveloped extensions in the area for the first time since the field was discovered two years ago. These figures would seem to indicate that drilling and completion activity should continue to decrease.

The actual operations in the field at this time are at the lowest level in more than a year, and new drilling permits are also slowing up. If these conditions continue to hold in the field, assurance will be given that the field will remain completely controlled, which will result in stabilization of conditions in the entire oil industry.

Another fact showing that major oil companies believe the largest part of the drilling campaign in East Texas is coming to a close is the increase in activity in several other areas of the Nation, both proven and virgin.

Standard of California to Sell Butane Plants

According to an agreement whereby the Standard Oil Company of California will cease to be identified with properties of a public utility nature through its sale of the securities it held in the Pacific Public Service Company, to the Pacific Gas & Electric Company, the company will dispose of its butane plants to an outside company.

The Standard Company has been operating butane plants under its subsidiaries, the Natural Gas Company, of Washington, and the Natural Gas Company of Oregon.

Ranger Storage Oil Delivered to Houston

The 1,500,000 barrels of storage oil recently purchased by the Stanolind Crude Oil Purchasing Company from Sinclair-Prairie Oil Marketing Company will be used in filling a contract for supplying the Sinclair Refining Company at Houston, according to R. S. Ellison, president of the Stanolind Crude Oil Purchasing Company.

Mr. Ellison stated that the Sinclair-Prairie Oil Company supplies the oil in the Ranger, Texas, field for which the movement contract is held by Stanolind and that the inability of the former to supply all the required amount of crude from leases made it necessary to move storage oil from Ranger to Houston.

Oklahoma's Allowable Production Is Reduced

Oklahoma's allowable oil production for September will be slightly more than 12,000 barrels a day less than during August. The Oklahoma City field bore the brunt of the decline, the Corporation Commission fixing the fields allowable production at 75,720 barrels a day.

Another Deep Oil Producing Horizon Found

The second deepest oil production in Texas and among the deepest in the world has been found near Bay City, Matagorda County, Gulf Coast, Texas. A well blew out at a depth of 8,000 feet and was completely out of control. The well, a wildcat, was not equipped with a Christmas tree at the time of the blow out, which carried 2,800 feet of drill stem from the hole. The new producer is five miles from nearest production, the Markham field, where production is found at 3,250 feet.

Excessive Gas Taxes Injuring Trade

Gasoline sales are decreasing enormously in some localities where gasoline taxes are exorbitant, while in many sections where the tax is regarded as reasonable, the reverse is true.

In Limestone County, Alabama, the pyramided tax is now nine cents a gallon; a five-cent state tax; a three-cent county tax and a one-cent federal tax. It is stated that more than 1,000 automobiles have been placed in dead storage or sold within the past few months and that many persons are now using horse-drawn vehicles. Automobile registrations in the county decreased from 225 in April, 1931, to 22 in June, 1932, and gasoline tax collections have declined 60 per cent.

Oklahoma Checking Oil Runs with Meters

Lieut. Col. Cicero I. Murray, Oklahoma proration officer, is installing meters on production outlets. The meters have a paper disc on which an indicator records the flow. Above is a register recording the amount of oil run. The meters are being checked by national guardsmen. An increased assessment was invoked upon Oklahoma City operators to take care of a demand for additional aid in checking production.

Allowables In Several Texas Fields are Cut

Ten per cent reductions in the allowable outlet of the Yates, Van and Gulf Coast fields, totaling 22,500 barrels a day, with proration orders continued in the Conroe, Duval County and Tuleta areas, were made effective the first of September by the Texas Railroad Commission.

The reduction of other Texas fields (outside of East Texas) is expected to care for the greatest portion of the increase made effective in East Texas.

Propose 3-Cent Gax Tax Limit

Colorado voters this fall will vote on a proposed amendment to the state constitution limiting the gasoline tax of the state to three cents a gallon and further limiting the ad valorem tax to be levied by counties for road purposes to one mill. The proposed amendment was called for by popular petition and was ordered placed on the ballot.

Teagle Favors Shorter Working Week

Walter Teagle, president of the Standard Oil Company of New Jersey, in a prepared statement has expressed his views on unemployment. A part of the statement was as follows:

"It has been but 45 years since a United States commissioner of labor wrote in his annual report that the world was suffering from overproduction, due to machinery, and that it is almost futile to expect much further progress or prosperity. But since then we have gone a long way toward abolishing the seven-day week and the twelve-hour shift. The six-day week and eight-hour day absorbed more labor; and the fewer hours and more machinery men lifted their standards of living. In doing so they discredited the secretary's forecast; we enjoyed the greatest era of prosperity in our history, through spreading work and adding to leisure.

"To meet the present emergency it is my view that in those cases where a ten or twelve-hour day, or a seven-day week are still in effect, there should be an immediate reduction of these excessive hours to make places for more workers, and that where employes have not already gone on a shorter working week, the hours should be further divided."

Latest Activities in t

Figures on maps indicate average prices paid for oil in adjacent fields

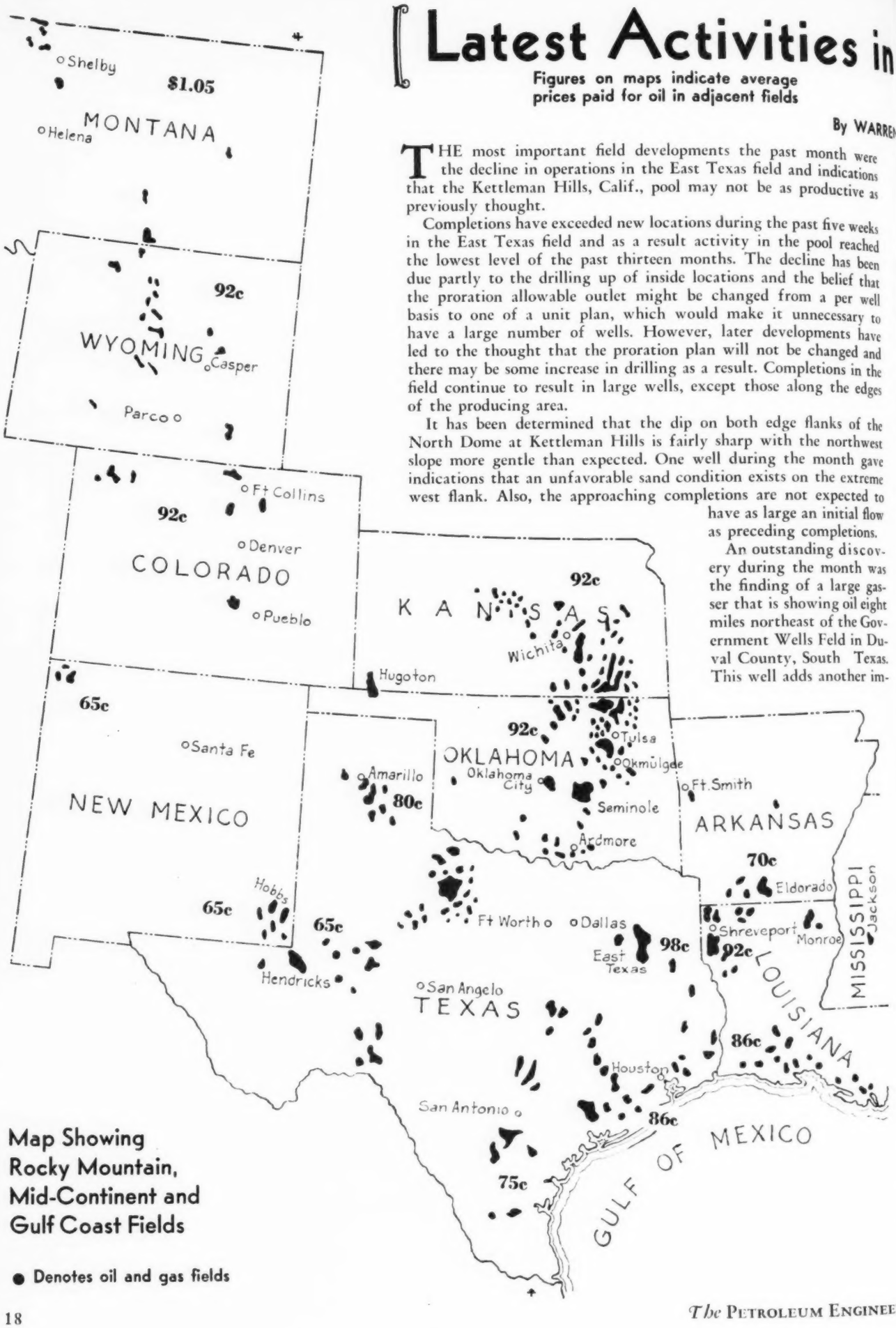
By WARREN L.

THE most important field developments the past month were the decline in operations in the East Texas field and indications that the Kettleman Hills, Calif., pool may not be as productive as previously thought.

Completions have exceeded new locations during the past five weeks in the East Texas field and as a result activity in the pool reached the lowest level of the past thirteen months. The decline has been due partly to the drilling up of inside locations and the belief that the proration allowable outlet might be changed from a per well basis to one of a unit plan, which would make it unnecessary to have a large number of wells. However, later developments have led to the thought that the proration plan will not be changed and there may be some increase in drilling as a result. Completions in the field continue to result in large wells, except those along the edges of the producing area.

It has been determined that the dip on both edge flanks of the North Dome at Kettleman Hills is fairly sharp with the northwest slope more gentle than expected. One well during the month gave indications that an unfavorable sand condition exists on the extreme west flank. Also, the approaching completions are not expected to have as large an initial flow as preceding completions.

An outstanding discovery during the month was the finding of a large gasser that is showing oil eight miles northeast of the Government Wells Feld in Duval County, South Texas. This well adds another im-



Map Showing Rocky Mountain, Mid-Continent and Gulf Coast Fields

● Denotes oil and gas fields

the Oil Fields

Figures giving production of individual fields will be found on page 15

L. BAKER

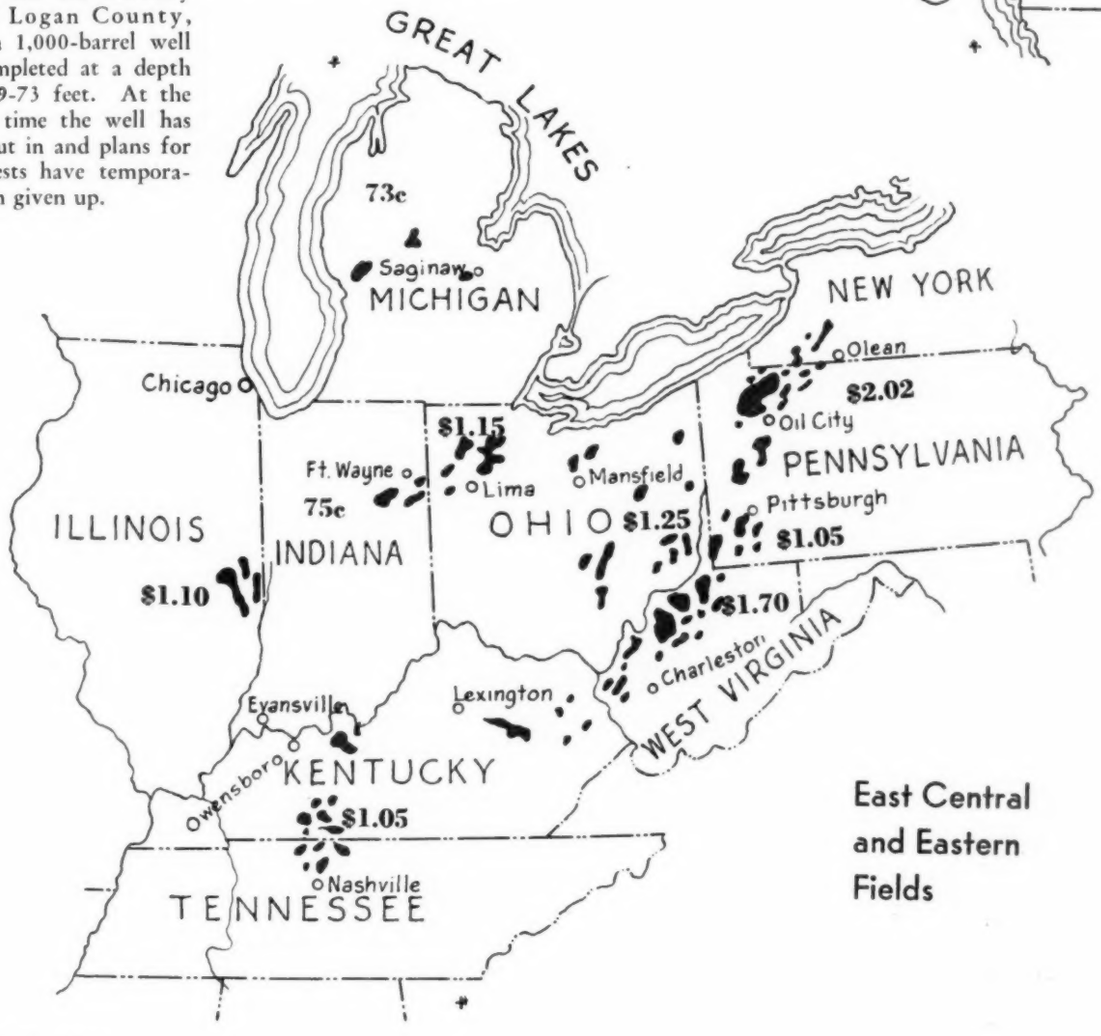
portant chapter to the numerous new areas opened recently in this vicinity and indicates additional activity. The most important development within the Government Wells pool proper was the intrusion of water from the south and southeast, defining the pool in this direction, although separate producing regions have already been found at distances farther away.

Another strike in South Texas was the finding of production at 5,841-51 feet in the Keeran field of Victoria County. A 1,000 barrel well was completed at this depth, which opens the deepest producing horizon in the county.

The Conroe field of Montgomery County, Gulf Coast, Texas, was given small extensions to the south and east by completions during the month. It is possible that the producing territory may exceed previous estimates in these two directions and at the same time several shallower producing sands have been found by one test drilling southeast of production. Sufficient wells are nearing the pay sand in the territory to give definite indications of the producing possibilities during the next month.

Operations are increasing in Oklahoma as operators seek additional oil pools. The most important development in this state during the month was the finding of deeper production in the old McCully pool of Logan County, where a 1,000-barrel well was completed at a depth of 6,169-73 feet. At the present time the well has been shut in and plans for other tests have temporarily been given up.

California Fields



East Central and Eastern Fields

Haystellite-Composite Rod

puts *teeth*

on your Bits

DIAGRAMMATIC enlargement of a deposit of Haystellite-Composite Rod, showing the hard, tough particles of Haystellite ready to form numerous small sharp teeth. (*Left*)

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* *Patent applied for*

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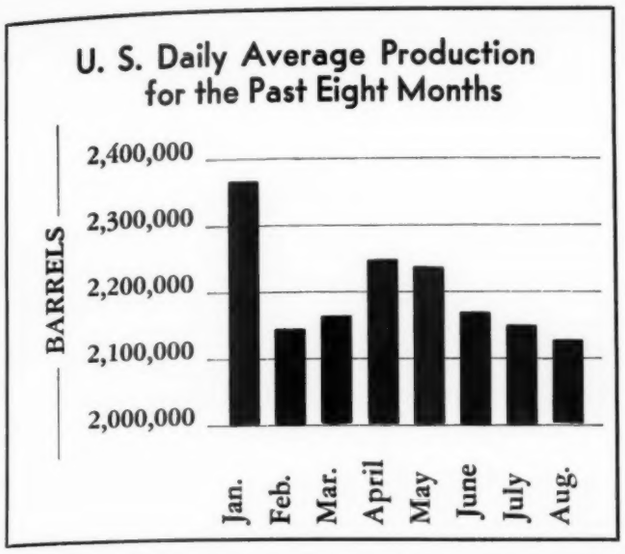

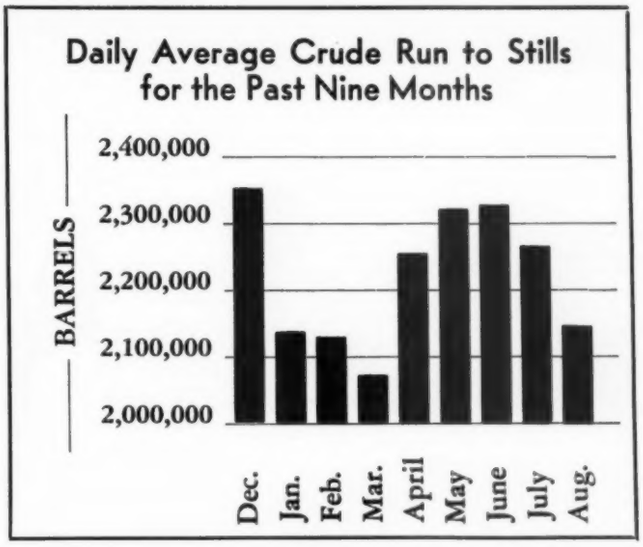

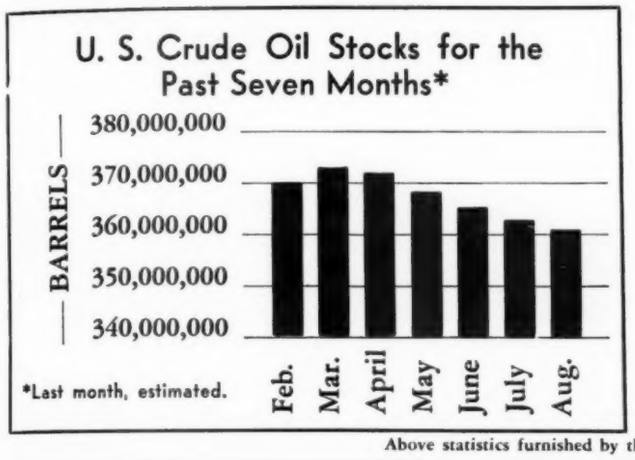

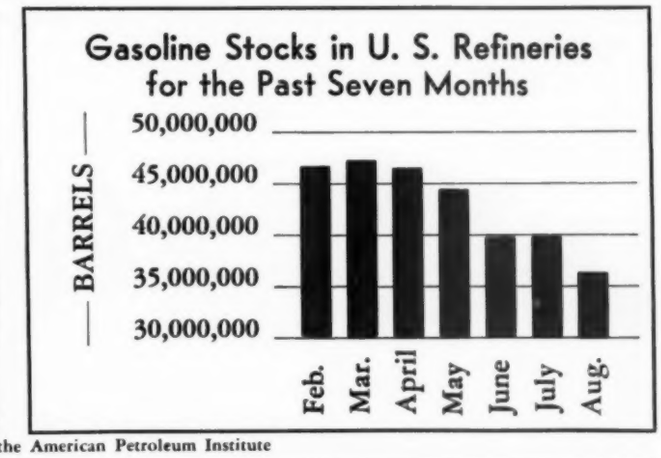

Above statistics furnished by the American Petroleum Institute

Summarized Operations in Active Fields for August, 1932

Fields	Completions	Producers	Locations	Rigs	Drilling Wells	Depth of Production	No Casing Strings	Gravity of Oil	Type of Tool Used
Texas									
East Texas	687	678	564	203	269	3600	2	40	Rotary
Duval County	26	20	40	12	29	2300	2	22	Rotary
Panhandle	14	11	16	10	31	2900	2	40	Rotary
Conroe	10	9	11	4	16	5200	2	38	Rotary
Oklahoma									
Oklahoma City	17	17	13	27	42	6500	3	39	Rotary
Kansas									
McPherson	23	5	17	13	45	2900-3400	2	38	Rot.-Cab.
Ellsworth	6	5	8	4	29	3300	4	37	Cable
California									
Kettleman Hills	3	3	1	2	15	8300	3 or 4	40	Rotary
Long Beach	7	7	0	1	5	7000	3	26	Rotary

Field Activities by States for August, 1932

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1931 (in Barrels)
	August	July	August	July	August	July	August	July	August	July	
Arkansas	2	4	0	0	3	1	7	5	24	20	15,425,000
California	26	41	22	29	22	13	19	16	109	115	188,575,000
Colorado	0	1	0	1	2	2	8	7	65	64	1,510,000
Illinois	6	4	4	1	....	....	1	2	17	17	4,850,000
Indiana	27	9	14	5	....	....	3	2	62	60	830,000
Kansas	73	58	49	44	69	68	50	53	103	140	37,950,000
Kentucky	62	39	35	30	....	....	12	11	67	71	6,490,000
Louisiana	47	43	16	22	54	45	43	34	88	85	22,325,000
Michigan	37	9	26	7	....	....	40	39	66	73	3,730,000
Mississippi	6	0	4	0	....	1	2	3	14	14	Gas Prod.
Montana	6	2	3	1	1	....	9	6	35	15	2,855,000
New Mexico	6	4	4	4	....	....	6	7	50	49	15,250,000
New York	19	7	17	7	....	....	3	4	15	18	3,400,000
Ohio	69	44	51	31	....	....	31	28	109	105	5,315,000
Oklahoma	124	71	92	51	134	88	120	99	302	220	177,750,000
Pennsylvania	120	47	97	40	....	....	21	13	85	84	11,225,000
Tennessee	0	0	0	0	....	....	0	0	13	13	8,000
Texas	1025	889	864	747	999	850	401	463	879	940	330,720,000
West Virginia	15	17	13	16	....	....	20	12	40	39	4,480,000
Wyoming	5	1	4	0	....	....	14	14	68	62	14,725,000
Total	1675	1290	1315	1036	1285	1068	810	820	2195	2210	847,413,000

Progress of Major Pipe Line Work

By J. H. DAMERON

A REVIEW of the past month's developments in pipe line work shows the completion of two new lines, the starting of additional new work and further plans for additional reconditioning work. It is probable that repair work will be scheduled on a large scale for many months. Various reports indicate that this type of pipe line maintenance will be in the spotlight on the Pacific coast for the next several months. Numerous lines that have been in the ground for a long period of years in that area are to be reconditioned. The lines are to be uncovered and pitted pipe will be spot welded or "patched." When advisable, sections of the line will be cut out and replaced with new pipe.

Several equipment manufacturers are looking to the repair jobs for considerable business during the next two years. Several companies in the eastern and mid-continent sections are reported to have plans calling for the repair of long sections of line. Much of this work is under way or nearing completion in the eastern section at this time.

Illinois Pipe Line Company expects to complete a 63-mile repair job on its line from Elk Basin to Greybull, in Wyoming, early in September. This line was built with six-inch and eight-inch pipe and about 30 miles of the line was replaced with eight-inch pipe.

The same company has replaced about 6½ miles of line near Fort Worth, Texas. To give as much relief as possible to unemployed, about 700 men were employed to build the six-inch welded oil carrier. Except for welders and a few others only unskilled labor was used. The men were paid forty cents per hour and employment was spread out to afford as many jobs as possible.

On a repair job of the Southern California Gas Company's Midway-Los Angeles line laid in 1912, manual labor is used as far as possible. The job is being spread out over a large group as possible and the men are working on a three-day week schedule.

The only new work of consequence started during the month was by the Southern Union Gas Company, Dallas, Texas, when the company started work on a 25-mile, six-inch line in New Mexico. The line originates in the Ute dome area and runs to Kutz Canyon, where it ties the Company's main line going to Albuquerque.

All construction work is being done by company employees with field work under the supervision of Wofford Cain. Ditching is being done by hand and machine. The line is being built to augment the main line supply and construction is expected to be completed by the latter part of September.

In California the Southern Counties Gas Company completed its line running from Long Beach to San Diego, and the line was placed in service the early part of September. San Diego has been using manufactured gas and the change over is to be made during September.

Apex Construction Company, Williams Brothers, Inc., subsidiary has completed the construction of a combination four and six-inch screw line for the Texas Pipe Line Company. The new line is forty-six miles long and starts in the Port Barre field in coastal Louisiana and terminates on the west bank of the Mississippi River near Baton Rouge. One 80,000-barrel capacity steel tank was erected at the line's terminal. Crude will be accumulated in the tank and loaded in tankers for coastal shipment. Texas Company and Gulf Refining Company production will be handled through the line.

Texas Pipe Line Company completed a short six-inch screw line from the Conroe field to its central Texas main line in September. This affords the Conroe area its second pipe line outlet, the first being built by the Humble Pipe Line Company.

Additional outlet for the north Duval County fields in southwest Texas is being provided by the Magnolia Pipe Line Company. A booster station on its main line in that general area is being placed in service after being idle for several years. The booster station will increase the company's capacity from 8,000 barrels daily to 12,000 barrels daily.

It is reported that a group of independent operators is planning the organization of a pipe line company to build a gathering system and short main line in that area. The main line would terminate at a railroad about 30 miles distant.

Another chapter is due to be written about the middle of September in the Detroit, Mich., fight for natural gas. Several major interests have made overtures to bring natural gas to Detroit, which at present is using manufactured gas. These proposals have been to extend relatively close transmission mains and one company proposes to build from the fields in Michigan. So far little headway has been made towards obtaining a definite agreement that would permit the costly building of a main artery to the industrial city. Some doubt has been expressed concerning the reserve in the Michigan fields.

The city council recently voted to hold an election during the middle of September to vote on a proposal that the city own and operate a natural gas distributing system. In the event such a proposal is carried the sponsors of the movement will consider the proposals to build a line from the Michigan fields to Detroit and the proposals of various major units desiring to enter Detroit with a transmission line.

Efforts to get natural gas for Terre Haute, Ind., again took form when a proposal was made to build a short line from a near-by area and supply the distributing company with gas. Some time ago a subsidiary company of the Missouri Kansas Pipe Line Co., built a line from the Kentucky fields to Terre Haute. Soon after completion of the line the company was tangled in litigation and the line into Terre Haute has not been operated.

The Missouri Public Service Commission last week turned down the proposal of the Industrial Fuel Gas Company, to build a large diameter transmission line from the Hugoton, Kans., field to St. Louis, Mo. The commission refused to grant a certificate of necessity and conveyance.

Most companies have completed their lateral line construction work scheduled for the summer. In scattered sections some of this work is still in progress and the only new lateral work announced during the early part of September was a short line to Atlanta, Iowa, by the Northern Natural Gas Company.

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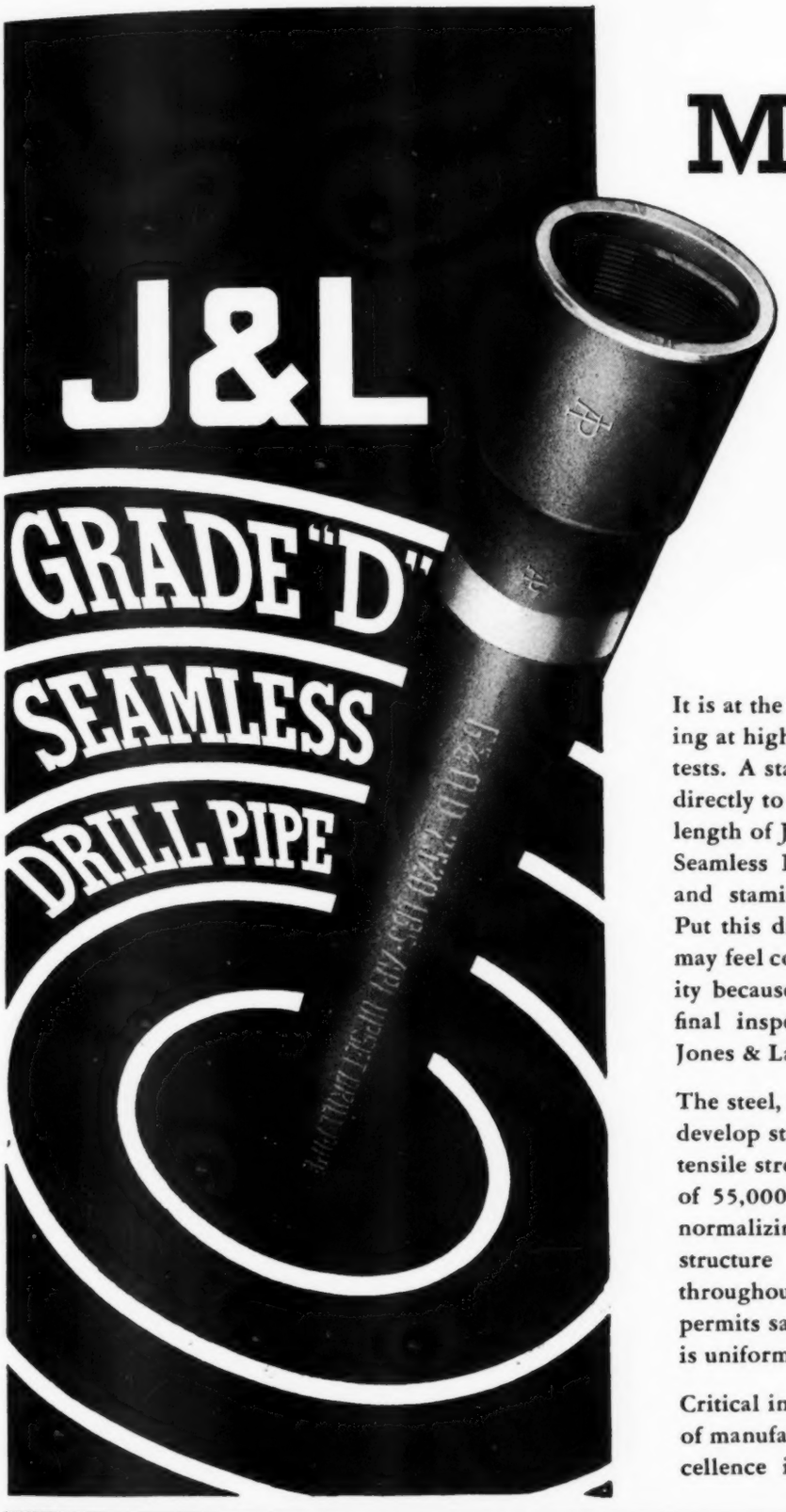
PIPE LINES UNDER CONSTRUCTION AND CONTEMPLATED

Type Line	Company Name	Headquarters	Point of Origin	Terminal	Size Pipe	Length in Miles	Remarks
G. L.	Bivens, C. E., et al.	Laramie, Wyo.	Baggs Field	Laramie, Wyo.	12"	104	Plan to build in 1932. Granted extension of time.
O. L.	Champlin Oil Refg. Co.	Enid, Okla.	(See Remarks)				Plan to build four booster stations on Oklahoma City-Enid 8-inch line.
G. L.	Columbia Gas & Elec. Co.	New York, N. Y.	Ky. or Pan Eastern Line	Detroit, Mich.	20"	220	Considering going to Detroit, Mich., with line and to Toledo.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Chicago, Ill.	Detroit, Mich.	20"	200	Plan extension of Panhandle line to Detroit.
G. L.	Continental Constr. Corp.	Chicago, Ill.	Point in Ill.	Wilwaukee, Wis.	20"	160	Under advisement.
G. L.	Cities Service, Insull, Texas Corp. & S. O. N. J.	(See Remarks)					Rumored considering building 1,500-mile project from Panhandle to Eastern cities.
G. L.	Golston, Roy D.	Tyler, Tex.	Brownwood, Tex.	Lampasas, Tex.			Considering building gas line.
Ga.L.	Great Lake Pipe Line Co.	Kansas City, Mo.	Okla. Midcontinent	Great Lakes Region	4-6-8"	1440	Considering increasing station capacity.
G. L.	Great Northern Gas & Utilities Co.	Minneapolis, Minn.	(See Remarks)				Planning gas line from Baker-Glendive area in Montana to Minneapolis and St. Paul.
O. L.	Humble Pipe Line Co.	Houston, Texas	Conroe, Main Line		8"	28	Work half complete.
O. L.	Illinois Pipe Line Co.	Fort Worth, Tex.	(See Remarks)				Completed 7-Mile 6-inch line from main line to Fort Worth refinery.
G. L.	International Util. Corp.	New York, N. Y.	Alberta, Canada	Vancouver, B. C.	20"	500	Proposed
G. L.	Kentucky Public Service Co.	(See Remarks)					Posted bond to build short line from Hart County, Ky., to Bardstown, Ky.
G. L.	Jerome Drumheller	Spokane, Wash.	Cut Bank, Wyo.	Seattle, Wash.	20"	500	Proposed.
G. L.	Lycoming Nat. Gas. Corp.	New York, N. Y.	Tioga Field, N. Y.	Syracuse, N. Y.			Building short line from Syracuse County line to Syracuse.
G. L.	Lycoming Nat. Gas Corp.	New York, N. Y.	Tioaga Field	Potter County Field	20"	40	Plan to build soon.
G. L.	Lewiston Nat. Gas Co.	Lewiston, Mont.	Armells Structure, Mont.	Montana Towns	4-6"	100	Proposed.
G. L.	Missouri Valley P. L. Co.	Omaha, Neb.	Point in Minnesota	Minneapolis, Minn.	16"		Proposed along with extension work in Iowa.
G. L.	Montana-Dakota Power Co.	Minneapolis, Minn.	Williams, N. D.	Minot, N. D.	12"	100	Applied to N. D. Commission for permission to build.
G. L.	Mo.-Kans. Pipe Line Co.	Chicago, Ill.	Russellville, Ky.	Nashville, Tenn.	10"	50	Proposed.
G. L.	North Central Gas Co.	Casper, Wyo.	(See Remarks)				Reported planning 100 miles of extension work in Nebraska and near-by territory. Part of work underway.
O. L.	Old Dutch Refining Co.	Muskegon, Mich.	East Michigan Fields	Muskegon	4"	100	Plans in abeyance.
G. L.	Ohio Oil Company	Findlay, Ohio	Weiser Field, Idaho	Boise and Northwest Area			Filed application for conveyance certificate.
G. L.	Pacific Gas & Elec. Co.	San Francisco, Calif.					Have appro. for $2,000,000 expansion campaign. Building 45 miles of 26-inch.
O. L.	Presidio Petroleum Co., Ltd.	Los Angeles, Calif.	Midland, Tex.	Topolobampo	10"	640	Propose to build to Mexican Port and erect two refineries, one at Chihuahua for domestic trade and the other at tidewater for export trade. Plan to parallel oil line with gas line to Chihuahua. J. F. Sadler promoting.
G. L.	Peninsular Pipe Line Construction Co.	Detroit, Mich.	(See Remarks)				Reported planning building 160-mile line from Mt. Pleasant field in Mich. to Detroit.
O. L.	San Juan Pipe Line Co.	Los Angeles, Calif.	San Juan County, Utah	Farmington, N. M.	8"	92	Reported planning to build this summer. Line will have three stations.
G. L.	Santa Maria Gas Co.	Santa Maria, Cal.	Santa Maria	San Ruis, Obispo	8"	21	Under construction.
	Standard Oil Co., of Kansas		(See Remarks)				Plan to build 150 miles 8-inch into western Kansas.
	Southern Union Gas Co.	Dallas, Texas	Ute Dome	Kutz Canyon, New Mexico	6"	25	Under construction.
O. L.	Texas Pipe Line Co.	Houston, Texas	Port Barre, La.	Mississippi Terminal	4-6"	46	Completed.
G. L.	Wasatch Gas Company	Ogden, Utah	Ogden, Utah	Pocatello, Idaho	10"	140	Applied for permit to build welded line.

TABLE

O L.—oil line
G. L.—gas line
Ga. L.—gasoline line



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The Month's Activities in Refining*

By F. R. STALEY

FOUR contracts have been let by the Shell Oil Company of British Columbia, Ltd., in connection with the construction of a million-dollar refinery being erected at Burnaby, B. C. The Foster Wheeler Company, Ltd., Ontario, will design and erect the distillation units. The refinery office is now completed, and the ocean docks, railway sidings and roads are nearing completion.

The Alcorn Combustion Company is rebuilding the furnaces on the Dubbs units for the Derby Oil Company, Wichita, Kans.

The Texas Pacific Coal & Oil Company is installing additional hot oil pumping equipment for its cracking plant in the Fort Worth refinery.

The Associated Petroleum Corporation is preparing to start operations at the Allen, Okla., refinery.

The Barnsdall Corporation has purchased control of the Mona-Motor Oil Company of Council Bluffs, Iowa.

The Stearns Roger Manufacturing Company, Denver, Colo., has completed a high tension transmission electric line from the Midwest Refining Company power house at Salt Creek to the refineries of the Standard Oil Company of Indiana at Casper, Wyo.

The Industrial Department of the Canadian National Railways is erecting a small refinery at Regina, Sask., Canada.

The Standard Oil Company of Indiana has purchased all of the physical properties of the Standard Oil Company of Kansas. This includes a $20,000 refinery at Neodesha, Kans.

Applications have been made to the Italian Government for permission to double the cracking capacities of the three refineries operating in that country.

The U. S. Bureau of Mines has recently issued Information Circular No. 6641 on Petroleum Refineries in the United States. The location, capacity, and type of plant is shown.

The Standard Oil Development Company opened the hydrogenation plant at Bayway, N. J., last month for inspection to a large number of technical men and writers. After two years of operation it has been demonstrated that it is possible to manufacture hydrogenated petroleum products on a commercial basis. A new motor oil to be marketed under the brand of Essolube was announced. This oil has remarkable specifications. In addition to the lubricating oils, a line of commercial solvents has been developed, also a safety fuel for aircraft and speed boats. This fuel will not ignite under normal temperature conditions.

The Second Annual Road Oil Congress will be held in Tulsa, October 13 and 14. W. B. Way is chairman of the program committee. Road oil specifications, its application, and the methods of constructing roads with the use of oil will be discussed.

The U. S. Bureau of Mines reports the sales of road oil increased 28.5 per cent in 1931. Petroleum refineries in the United States sold over seven million barrels of oil, which is used principally on secondary road systems.

Many excellent papers of interest to petroleum refiners were presented before the Division of Petroleum Chmistry of the American Chemical Society at the Denver meeting.

Natural Gasoline

The Internal Revenue Commission held that natural gasoline is a liquid product of crude petroleum and is subject to the tax imposed by law of 4 per cent of the transportation charge when carried by pipe line.

The Compania Mexicana de Gas, S. A., has been granted a concession to install and operate a natural gasoline plant in Monterrey, Nuevo Leon, Mexico. A daily capacity of 700,000 cubic meters of gas is allowed.

Refineries in all divisions ran less crude last month than during the preceding month.

Figures in red show per cent refining capacity operated.

*All statistics as of September 1.

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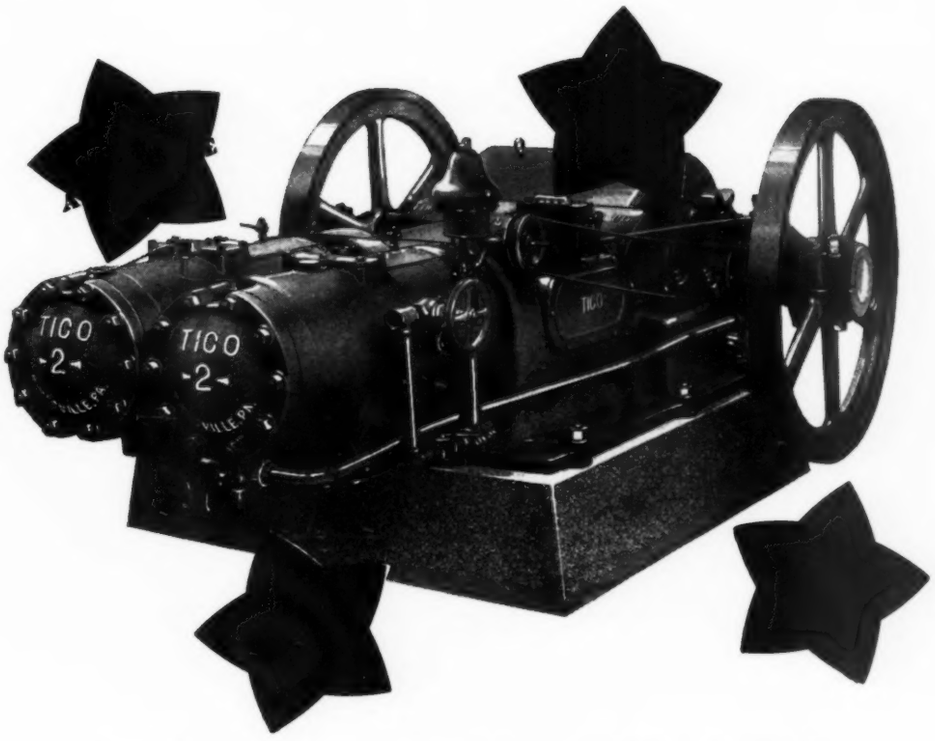

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Unconsolidated Sands, Migrating Water and Gas Pressures Are Texas' Cementing Problems

By WARREN L. BAKER

THE unconsolidated producing sands and gravel formations found in many Texas areas, particularly in the Gulf Coast region, together with frequently encountered migrating water and upper gas pressures, offer considerable difficulty to the oil operator in successfully cementing, completing and producing his wells. These difficulties have led to the development of various improved methods and devices for performing cementing and completion work. Cementing and completing operations under such conditions require close and careful supervision of the chosen method.

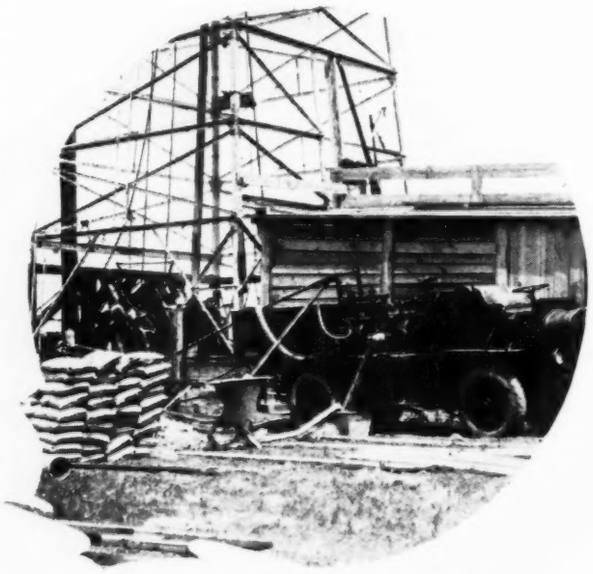
Cementing Operations

The problems of proper oil well cementing are greatly complicated by soft, cavey and porous formations. These being subject to rapid and easy migration of fluid, often yielding gas pressures that agitate the cement to the extent that its hardening progress is retarded.

Because of the easy migration of water through these porous horizons the problem of arresting water intrusion into the pay sands is a serious problem. It is highly desirable that the proper water-cement ratio be used for a good cement job.

It is well known that cement, after being mixed with water, hardens through a chemical reaction between the cement and water generally expressed by hydration of the cement. The water ratio used in oil well cementing is greater than needed for complete hydration due to the fact that grout must be sufficiently fluid to be pumped down the hole.

This excess water (water not used in the chemical process of hydration) eventually escapes through evaporation or drainage unless it remains loosely entrapped in cavities or pores. It is very important for proper cement setting that these pores or cavities be eliminated as nearly as possible, since any water or other fluid which can enter the grout after it has hardened must do so through the openings once occupied by the mixing water which was not utilized in the chemical changes incidental to hardening. Because of the presence of water in many formations above the producing horizons, cementing operations in Texas are usually performed with low water-cement ratio so as to secure greater resistance to the encroachment action of water and gas in a well.



Getting ready to cement a deep well

Where unusually porous sands are encountered, it has been found that the water used in mixing will frequently penetrate into the sand, leaving a layer of cement on the wall of the earthen hole. When this condition occurs the layer of cement becomes so hard that it is impossible to get all of the cement out of the casing.

General well cementing practice in Texas entails first the placing of a portion of thin cement in the hole. This will clean the hole's earthen walls, carrying all loose mud up with it, creating a more plastic condition behind the casing. Then, a heavy mixed cement grout is used for forming an impervious dam against the migration of the fluid back of the casing string.

Frequently in Texas wells the presence of water or gas is encountered adjacent to or below the location where it is desired to place the cement grout. This condition, due to the pressure exerted by the gas or water, causes an agitating action in the bottom of the hole, preventing the proper hardening of the cement. Texas operators and cement companies now overcome this difficulty by placing a back pressure on the hole of sufficient force to overcome that exerted by the agitating agent at the bottom.

These difficulties have led to the development of various methods and devices for cementing and completion work. The two-plug process of cementing is generally used. By this method, circulation is first obtained to wash out all the cuttings, water and oil and afterward a portion of the mud column is displaced to make room for the first batch of cement.

Several new cementing devices and methods have found successful application within the past year, and some of these have been especially designed and adapted to handle conditions encountered in the Texas fields. Two of these processes are Full Hole Cementing and Multiple Stage Cementing.

For the former, the Full Hole Cementer tool is employed. This may be placed at any desired position in the casing string, and is lowered into the hole as a regular part of the casing. It is screwed onto the joint of casing where the cementing job is to be performed and consists of an inner sleeve at the lower end of which is a back pressure valve. The valve and sleeve rest on four shear pins. These break when the bottom cement plug strikes the back pressure valve, opning the cement outlets.

The chief advantage of this new cementing tool is that it allows the drilling of a full size hole into the oil sand. This is an important feature, since an equally large drainage area may be secured in the bottom of a hole by drilling one-half or two-thirds as deep into the sand as would be necessary with the ordinary practice of reducing the hole above the pay sand. This gives the operator a large margin of safety in practically eliminating the chances of drilling into bottom hole water. It also increases the useful life of the well, and the larger hole makes it easier to drill deeper, should this be desired later in the life of the well.

Multiple Stage Cementing is another process that has been

successfully used on a number of wells, particularly on deep cementing jobs. It was introduced by Erle P. Halliburton for cementing at more than one level behind a string of casing. One advantage of the method is that it is easier to cement long strings of casing with large amounts of cement, as it is not necessary to pump all of the cement down the entire length of the casing string and then a considerable distance upward behind the pipe. The method practically cuts in half the amount of time and pressure necessary to complete a deep cementing job using a large amount of cement.

The process is also useful where it is desired to protect some formation located behind the pipe. Thus, a regular cementing job may be done around the shoe to obtain a water shut-off and then another job can be done on the same string of pipe at a shallow level to provide the desirable protection of a formation. By protecting or sealing a formation is meant that cement is placed above, below or at the formation for the purpose of preventing migration of fluid either into or from the formation.

Multiple Stage Cementing is accomplished by placing a device at the proper point in the casing. This device allows the first batch of cement and plugs to pass through and down to the casing shoe. The second batch of cement will not go down past the device, the lower plug meets a restriction in the instrument and forces a sleeve downward, thus opening a set of ports through which the cement passes.

Completion Practices

After the water string of casing is set and cemented, usually just above the productive formation, the well is prepared to be drilled into the producing sand.

In a field where small wells and low formation pressures are found, medium weight casing head, valves and fittings may be safely used; but for deep, high-pressure wells the strongest and heaviest equipment must be provided. The majority of high-pressure wells are equipped so that each string of casing connects to a flanged head at the surface. After completion, the Christmas tree may be attached to the upper part of the flange head. Before penetrating a high-pressure horizon, all wells are equipped with a blowout preventer and frequently a large master gate valve. Dual-control equipment is installed to handle excessive pressures in many cases.

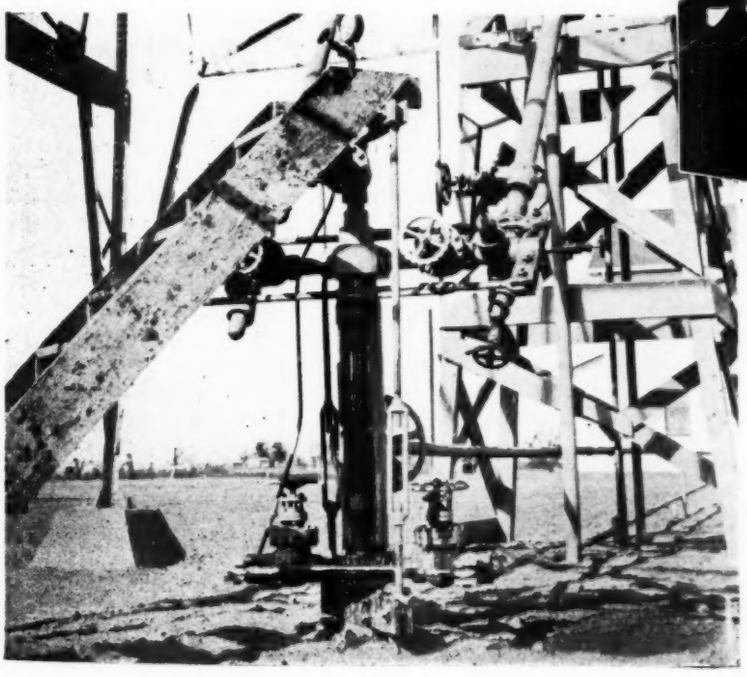
After these preparations have been made the actual operation of drilling into the producing horizon is commenced. It is customary, when drilling to a depth where a producing formation may be expected or when a change in formation occurs, to withdraw the regular drill bit and substitute in its place a core barrel. This device catches a sample of the formation, a study of which enables the driller to determine the possibilities of commercial oil and gas production, as well as the presence of bottom hole water.

In high pressure areas, the hole is kept full of heavy mud (12 to 1 pounds per gallon weight) during the drilling-in operation. It is necessary that the weight of the mud column be sufficient to exceed in weight the force exerted by the formation pressure if a blowout is to be prevented. The mud must also be fluid enough to hold all cuttings in suspension until they can be circulated to the surface. To secure such a mud, certain admixtures (many patented) are in regular use.

In wells completed by the rotary method, a common practice, it is necessary to clean the hole of the mud fluid and sediment so the well may flow. Several methods are used, but the most common is the washing-in practice. This is accomplished by running a string of two and one-half or three-inch tubing to bottom, or by the use of drill pipe. The first step is to circulate thin mud down the tubing for a number of hours, after which clear water is used as the circulating fluid. The displacement of the heavy mud column by the lighter water will lower the weight of the fluid column until the pressure of the well is sufficiently in excess of the fluid to blow it from the hole.

In high pressure areas, the well is sometimes brought in by bailing down the mud column until the fluid level begins to rise due to the reservoir pressure. The well is then shut in and the mud flow turned into a sump until oil appears. When the oil becomes clean it is turned into the oil and gas separators.

The productive sands in several Texas areas, particularly the Gulf Coast, are unusually fine grained, and are a source of trouble, due to their tendency to fill up over the drilled hole and to flow upward with the oil column. Screens, or strainers, and perforated pipe are quite generally used in these



Left: Producing well hook-up in the Van Pool. At top of the Christmas tree may be seen pressure gauge and to the right center is nipple through which temperature readings are taken.

See picture above for enlarged photograph of nipple.

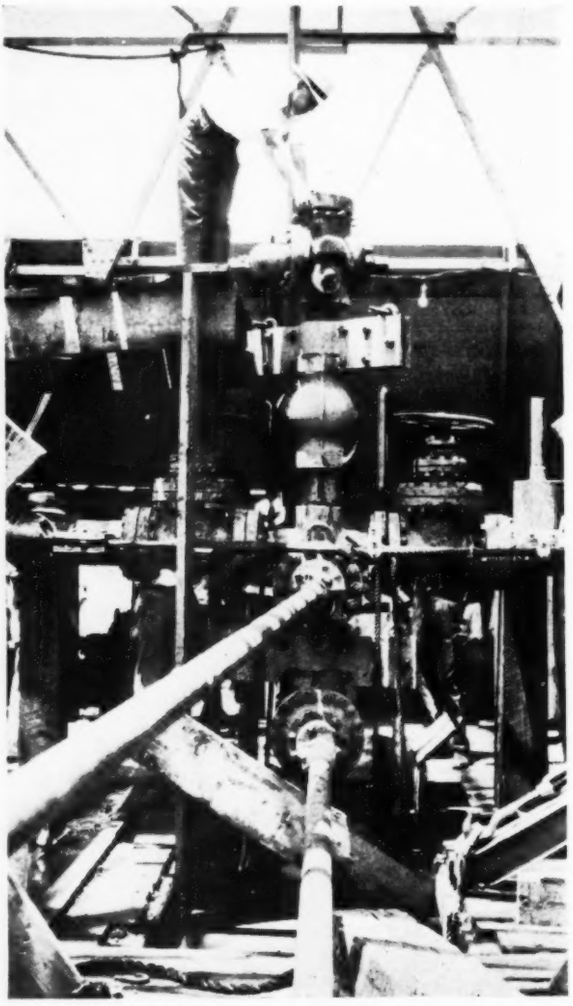
fields to keep the fine grained sand out of the hole. Sufficient pipe to line the face of the producing formation is used with enough blank pipe to extend up into the casing. The liner is usually made tight by a packing device.

It is frequently necessary to clean the hole of the mud fluid, when the well is being completed by the rotary method, before the screen or liner may be set on bottom. This is accomplished by the washing-in method previously described, with the exception that a nipple and wash blade or rotary bit are sometimes attached to the bottom of the screen or slotted pipe to assist in clearing the mud out of the hole and also to prevent the screen from turning when backing off the wash pipe used in setting it.

Sometimes the openings in a perforated liner become so tightly sanded up that it is difficult to wash them clean. It frequently occurs that openings in the upper portion of the screen pipe will be cleaned and all of the circulating fluid will pass through them instead of cleaning the entire length of pipe. A new device that provides a very effective and inexpensive means of thoroughly washing cavings, cuttings, bridges and heavy muck from behind a screen or perforated liner is a patented cement lining. It is very frequently used in connection with the previously mentioned Full Hole Cementer.

The chief feature of the operation of this cement lining is that it prevents the passing of the circulating fluid through the upper perforations and thus the entire pipe is washed clean. When this device is used in connection with the Full Hole Cementer, no wash pipe is used, as the screen is set prior to cementing and is washed clean during circulation operations before cementing. In this case the producing sand hole must be drilled before cementing. This permits the setting of a screen liner the same size as the casing string, since it is screwed onto the lower portion of the cementing tool. Whenever the two devices are used together, the setting of the liner, washing of cavings and cuttings from the hole, cleaning of the slots in the liner, and cementing of the casing string become one continuous operation. Cement does not clog the pores in the liner by reason of the fact that the grout never goes this deep into the hole, being passed out through the sleeves above the screen. The cement lining tool is drilled out simultaneously with the cement float plugs and casing shoe.

In a large number of Texas fields, it is practice immediately to tube completed wells. This practice is rapidly increasing in favor, as it has shown many advantages in achieving a more efficient flow of the oil through the pipe to the surface. Because of its smaller diameter the tubing string results in a considerable saving of gas. In areas where the wells are washed in to production, the wash string is often left in the hole to serve as tubing.



Washing-in hook-up on an extremely high-pressure well

It is entirely impossible to secure efficient oil well operation unless the equipment used is of the improved, modern type. So many greatly improved devices have been designed and placed on the market within the past few years, and so much has been learned about the underground producing conditions, that there is a marked change taking place in completion and producing practices. In this connection, the Van field, Van Zandt County, Texas, is one of the outstanding fields in the country.

This field has achieved its high ranking largely because it is a unitized block of acreage, which has made possible the use of standardized methods and equipment on all wells. It will be extremely interesting to watch the producing life of this field during the years to come, as it may greatly influence future production practices.

Drilling contracts in the pool stipulate that the holes are not to vary over five degrees from vertical and measurements of the course being taken by the hole are secured every 400 feet. Upon reaching the producing sand the well is drilled to a predetermined depth with rotary tools. A string of two and one-half-inch tubing, with a 3/16-inch liner is placed in the hole prior to washing the well in.

Of particular interest in the field is the equipment used. In addition to equipping the wells with tubing to conserve the gas, all wells flow through a positive bean type choke on the flow line side of the Christmas tree. Producing hook-ups include pressure gauges, from which daily readings are taken on the tubing and casing pressures. Daily readings of the oil temperature are also made by means of inserting a thermometer through a drilled hole in the end of a plugged pipe. It is only necessary to lift the thermometer out and take the reading. The Christmas tree hook-up, which is assembled prior to installing, includes a tubing head gate that permits retraction of the tubing, while a two and one-half-inch gate on a short six-inch pipe bradenheaded into the 10-inch casing permits the cleaning of the wells through either the casing or tubing.

Another very interesting region is the Big Lake field in Reagan County, where the second deepest commercial production in the world is found at depths ranging from 8,500 to 8,900 feet. The usual casing program for these deep wells is as follows: 110 feet of 20-inch, 90-pound pipe; 3,100 feet, 13 3/8-inch, 61-pound; 5,800 feet, 9 5/8-inch, 40-pound, and 8,000 feet of 7-inch, 30-pound.

Some remarkable operations have been performed in this pool, including cementing of 8,036 feet of casing in 14 hours, which included 13 hours' time for landing the pipe. These deep wells are also tubed under pressure while flowing, an operation that has been highly successful in reducing the tremendous gas-oil ratio of the producing wells.

The Petroleum Industry in Texas

By J. L. DWYER

WHEN Pennsylvania was experiencing the world's first great oil boom in the sixties, it was little dreamed that some day the wild territory constituting the state of Texas would become the leading oil-producing state in the Nation. Even as late as 1898, three years after oil was first produced in commercial quantities in the state, the oil business in the Lone Star commonwealth was looked upon with skeptical eyes.

Although only a few nearby early settlers knew about it, oil was benefiting Texans before Drake brought in his Titusville well in 1859. Indians attributed many curative properties to the blue-black water that collected in depressions among the rocks near Damon Mound, Brazoria County. It was suspected by white settlers that the "Rock Oil" was a seepage of the same kind of mineral fluid that they had heard was bringing great wealth to Pennsylvania, and shortly after the Civil War several wells were drilled in 1866 near Oil Springs, in the vicinity of the present town of Chireno, Nacogdoches County. However, production was small and interest soon waned.

It was not until 11 years later (1877) that interest in oil was revived by the finding of shallow production near Nacogdoches. A number of wells were drilled to the producing horizon at 200 feet. The state's first oil pipe line was built at this time, running a distance of five miles to the city of Nacogdoches, but with the playing out of production it was utilized as a waterworks system.

The actual development of the oil industry in Texas dates from the discovery of petroleum at Corsicana by the American Well and Prospecting Company while drilling a deep hole in search of water for municipal use. The encountered oil showings in this well attracted the attention of several ambitious men and resulted in the drilling of the first oil well, which came in on October 15th, 1895, with a production of two and one-half barrels per day. A second well made an output of 22 barrels from 1,040 feet.

Later wells boosted the output of the field to 6,500 barrels for the year 1897, but there was no market for the oil. Thus it happened that in 1898, a small refinery with a pipe line and storage system was erected by the J. S. Cullinan Company, which later was to become the Magnolia Petroleum Company.

The Corsicana pool was the only production in the state until the finding of the Powell field in the same vicinity in 1900. However, possibilities of tremendous wealth from the oil business did not attract national attention until January 10th, 1901, when the now famous Captain Lucas gusher at Beaumont heralded a new epoch in petroleum history by spouting oil two hundred feet into the air from a depth of 1,100 feet. It is interesting that this important strike, generally credited as the forerunner of great activity in the state, was drilled with a crude rotary rig and equipment, which marked the beginning of rotary drilling.

Derricks sprung up in the new Spindletop field like magic and at one time there were 500 of them on 150 acres of land. Texas' production jumped from 2,119,000 barrels for the year 1900 to 4,394,000 barrels in 1901. Sour Lake entered the producing column in 1902, followed by the Batson field in 1903, Saratoga, Petrolia and Matagorda pools in 1904, and Humble and Dayton in 1905. New fields swelled the output in the state to 18,084,000 barrels in 1902, to 22,241,000 in 1904 and to 28,136,000 barrels during the 12 months of 1905.

After 1905 production fell somewhat until 1911, when the discovery of pools in Wilbarger and Wichita counties gave the industry a renewed impetus. These were the first important discoveries in North Texas since the Corsicana Strike, although Petrolia may be considered the forerunner of the new activity. Electra, in Wilbarger County, was the first great North Texas field.

While this field was still in the limelight, discoveries were made at Moran and Strawn in 1914 and 1915, but great development in the north Central district did not come until the discovery of the prominent Ranger field in October, 1917. The seething activity at Ranger was followed by the great Burkburnett field, which startled the world in 1918. One year later this field was producing 120,000 barrels daily. Desdemona followed the same year.

From 1920 to the present day fields have been found in ever increasing numbers and with greater regularity. Mexia was opened in that year, closely followed by deeper pay in the old Powell pool. Oil production was first found in the Texas Panhandle in May, 1921, with a wildcat producer in Carson County, although gas production had been found as early as 1919. The Carson County well resulted in widespread activity, with the resulting great production of 1926 and 1927, and which at the present time constitutes an important district of the state.

West Texas development began in May, 1923, with the discovery of the Big Lake field in Reagan County. It has spread into Winkler County and into Pecos County, where the prolific Yates pool is located. Other important strikes in this area have been the Church-Fields-McElroy pools of Crane County, the fields in Howard-Glasscock counties, the McCamey-Taylor field of Upton-Crane counties, and production at Big Lake, where the deepest producers in Texas are to be found.

Although gas production was found as early as 1911, oil production at Thrall in 1915, and the Somerset field in 1918, Southwest Texas did not become very active until 1921 with the discovery of the Mirando Valley field, near Laredo. The following year the Luling field definitely established oil producing possibilities of the area and has resulted in a continued play since that time. The area has received great impetus in recent years with the discovery and development of fields of Salt Flat, Darst Creek, Refugio and Pettus.

In 1925, a deeper producing horizon was found at Spindletop and the old field again became the site of an intensive drilling campaign. The drilling development resulted in the finding of production in five different pay horizons and boosted the field's output to over 100,000 barrels in September, 1926. Since that time there have been numerous strikes in the Gulf Coast.

Following the discovery of Boggy Creek in March, 1927, the eastern portion of the state was treated to a very extensive geophysical and geological play, with the result that the Van Field, Van Zandt County, was found in October, 1929. This is one of the most interesting fields in the state. Immedi-

ately after its discovery all the acreage owners in the area pooled their holdings under the unit plan of operation. As a result the field has been carefully and slowly developed.

In September, 1930, C. M. Joiner completed a wildcat producer in Rusk County, followed in December by the Bateman well eight miles to the north. In January, 1931, a well 14 miles north of the Bateman producer was completed in Gregg County. These wells started a storm of leasing and drilling activity, the greatest ever witnessed. The East Texas field has established many remarkable development and production records which are amazing.

In these two years, nearly 7,800 wells have been completed in the district, and have spread the proven productive acreage to a total of more than 113,000 acres, nearly 50 miles in length and ten miles wide. As many as 172 wells have been completed within one week. In some cases rapid drilling has enabled drillers to penetrate the 3,600-foot producing horizon in 72 hours time from surface to bottom. During the first two years of its life the field has produced 200,000,000 barrels of oil, and at one time (just prior to strict proration enforcement) the field made 848,350 barrels in 24 hours—a figure far exceeding production records of any field in the world.

Since 1911, production in the state of Texas has reached new peaks each year, and in 1928 it became the leading producer of the Union. A new all-time record output for any state in the Nation was established in 1931, when it produced 330,720,000 barrels—a figure exceeding the combined output of all producing states with the exception of California, and which represents a total almost equal to the annual quantity produced by all foreign countries. Latest figures of the American Petroleum Institute shows that at the present time the state is producing approximately 40 per cent of the Nation's output.

Texas' accumulated production up to January 1st, 1932, was 2,677,945,000 barrels, an amount produced in the last 35 years. Much of the oil in Texas has been found in relatively shallow pools, but a great deal of new production has been found at much greater depths. Today, oil producing horizons in the state extend from among the shallowest to the second deepest commercial production in the world.

Texas is also the leading gas producing state in the Union, with an annual volume which has increased from 5,500,000 cubic feet in 1911 to nearly 517,808,000,000 cubic feet in in 1930 for domestic consumption alone.

The state also holds major ranking in refining and pipe line activity, being second from the standpoint of refinery capacity with facilities for handling approximately 838,000 barrels daily. In pipe lines, the state is first in point of mileage of both oil and gas trunk lines.

Several of the world's largest natural gas transmission systems originate in Texas, the largest being the Natural Gas Pipe Line Company's 24-inch line to Chicago. This line carries gas from the Texas Panhandle, which is the world's largest known natural gas reserve.

It is evident that the present productive fields in the state do not define the extent of production and that many important extensions are logical conclusions. Thus far in 1932 Texas has accounted for nearly three-fourths of the completions and producers of the entire United States and approximately one-half of the rigs and drilling wells. This activity has resulted in the discovery of more promising new oil fields than are to be found in any other state, many of which are but awaiting the decline in activity at East Texas before active intensive development are commenced.

Any story touching on the history of the petroleum industry of Texas, or any statement concerning the importance of this industry to the growth of the state, would be incomplete without some discussion of the industry's contribution to the growth of the area.

The petroleum industry is one of the three or four major factors in the growth and development of the state of Texas, and as such its inclusion in any economic study of the region is imperative. The continued discovery of petroleum production has attracted a vast army of people to the oil fields of the state. The development of every new producing territory affects the movement of population, necessitates expansion of transportation and communication facilities, requires changes in banking, increase the value of property, and opens up new avenues of wholesale and retail distribution of both luxuries and necessities.

Every strike has been the signal for a wild rush discovery oil and for a complete change in the complexion of the surrounding countryside. Farmers who had formerly been able to earn a scant living suddenly found themselves owners of very valuable property. Small communities sprang up by the hundreds, the need for capital to finance the drilling operations expanded the banking facilities, the new communities had to be supplied with the necessities of life, and the new wells required immense quantities of industrial goods. If the strike proved to be the opening of a large producing area, the district gradually assumed the aspect of a settled community, the original shacks were replaced by real dwellings and roads were built to connect the community with the outside world, and provisions had to be made for transporting the oil to refining centers.

Population figures for a period of ten years show that 55 counties in which oil was found had an increase of 35.6 per cent in population, while the remainder of the 199 counties in the state showed but 20.6 per cent increase. Certain towns closely connected with the oil fields had even more startling gains in population, for instance; Breckenridge, 310 per cent; Amarillo, 178.4 per cent and Longview, 400 per cent.

The shipment of crude oil and, more particularly, of refined petroleum has been a very important factor in railway transportation. The availability of large supplies of fuel oil and gas has been one factor in attracting large industrial concerns to the district, thus furnishing comparatively lucrative employment to thousands of men.

Some idea of the tremendous importance of the petroleum industry to the state may be gained from the fact that no other industry has as large a payroll, pays out as much money in all kinds of taxes, has as large a capital investment, or pays out as much money in maintenance work.

Varied Surface Conditions in Texas Make Pipe Line Construction Difficult

By J. H. DAMERON

WITH virtually every variety of surface condition within its area of 255,896 square miles, the state of Texas presents pipe line construction difficulties of every description. The southeast section is level but dotted with marshes and swamps and winding bayous. The eastern section presents its sandy soil, timber and swamp country. The central section is rolling but spotted with rock and a belt of black wax soil. West Texas has its desert country, small canyons, rock sections and mountains, while southwest Texas has its rough and broken terrain. Even the plains of the Panhandle are not all that might be desired for pipe lining. Parts of the Panhandle are broken and difficult to cross, while the Cimarron river bottom is a difficult barrier for lines going north. Despite these natural obstacles the Lone Star state has the most imposing pipe line mileage of any state in the union, with about 40,000 miles of oil and gas lines buried within its borders.

This tremendous mileage, representing an investment of many millions of dollars, is of course, due to the vast development of natural resources in Texas and the 400 miles of coast line relatively close to the Mid-Continent. The latter offers many excellent harbor facilities conducive to the location of refineries on the coast as well as tidewater terminals for crude oil lines bringing their tonnage from the northern fields for water shipment.

Due to the natural gas reserves running into billions of cubic feet, expansive natural gas transmission systems have been built north out of the Panhandle to concentrated domestic and industrial markets. Lines originating in Texas deliver gas to consumers in 15 states and Mexico. Some of the systems are so connected that additional states may be served and one line is so tied in with another system that Panhandle gas could be delivered as far east as New York.

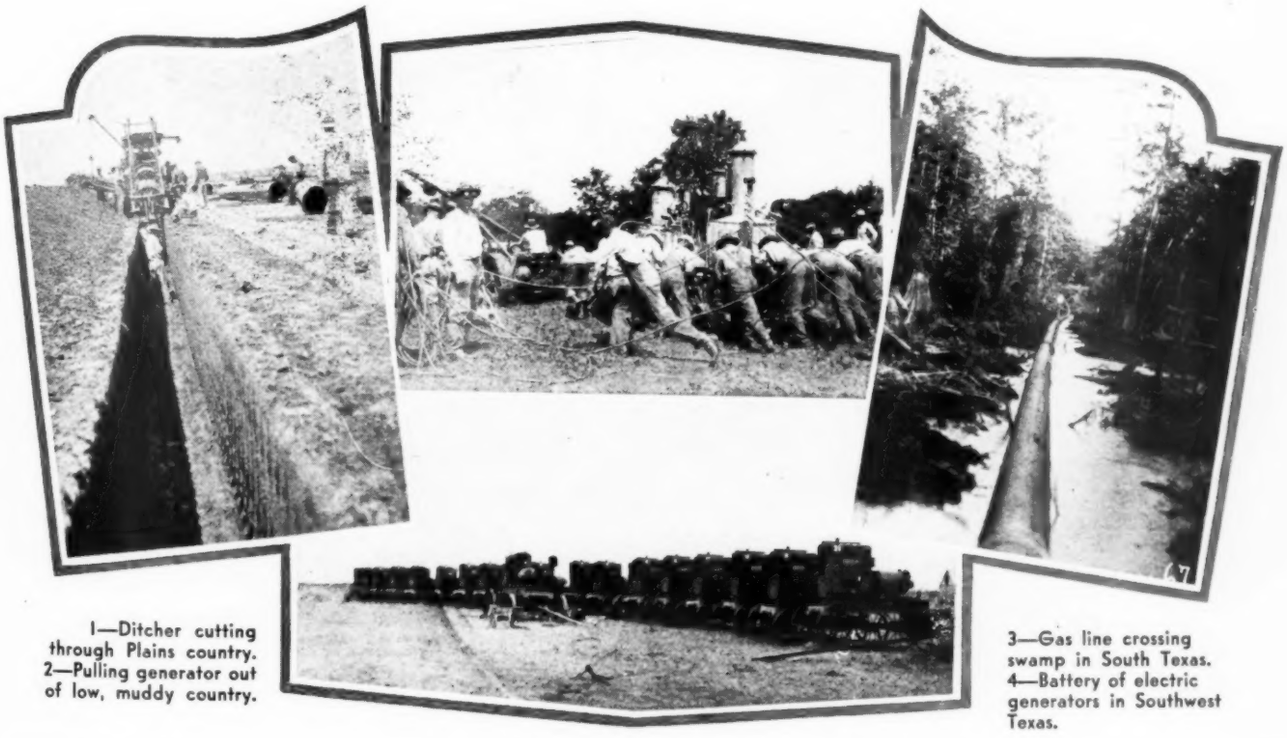
Combined with the variety of surface conditions the state has a temperature variation ranging from sub-zero to plus 100. Some sections are arid while others have a high average rainfall. Unfortunately the highest rainfall is in the low sections through which most of the trunk systems pass. Menacing also to construction speed are the fast striking northers in early winter.

The wide variety of soils add to the corrosion problem of buried lines as well as cause trouble in designing station foundations.

These multiple construction problems send the average cost of line construction to that of an average interstate system. While one part of Texas may make for low costs another section will send the cost soaring to the other extreme.

Ditching for an 8-inch line, for example, may be accomplished in some localities for three cents a foot and the contractor could realize a profit on that figure. From that, however, ditching costs may soar upward to as much as $1.00 per foot when it becomes necessary to traverse a large swamp during the rainy season.

For purposes of estimation the following table presents a fairly close average of main line construction costs. The estimates are for solid welded, composite built or screw coupled line in the smaller diameters. The low cost of standard pipe has brought about the low estimate.



1—Ditcher cutting through Plains country.
2—Pulling generator out of low, muddy country.

3—Gas line crossing swamp in South Texas.
4—Battery of electric generators in Southwest Texas.

Estimated Line Construction Costs

Pipe Diameter	Cost Per Mile
26-Inch	$30,000
24-Inch	27,500
20-Inch	25,000
18-Inch	22,000
16-Inch	18,500
12-Inch	14,000
10-Inch	12,500
8-Inch	9,000
6-Inch	5,500
4-Inch	4,500

Oil line station costs are estimated to be $100.00 per horsepower installed and the costs of gas compressor stations, their auxiliaries, cottages, etc., are estimated at $125.00 per horsepower installed. On this basis a main line oil pump station with three 500-horsepower engines, or their equivalent, would cost $150,000, while a main line compressor station with 5000 horsepower would cost $625,000.

Only through the development of new methods, material and machinery have some of the larger systems been economically possible. Great strides have been made in every phase of line construction from right-of-way to back filling.

The aeroplane is used extensively in survey work. Through the plains and rolling country the plane may be used for aerial scouting and as the scouting trip progresses into the more broken, wooded or swampy country aerial photography has been the means of saving thousands of dollars. By making an aerial survey the most desirable route is located, reflecting its savings in lowered costs of transporting material and equipment and continuing that savings on for years because of the better route for line maintenance. The plane is used often in selecting the site for stream crossings.

Crossing swamps once was a problem as black-looking as the swamps are dreary. On many of the recently constructed lines right-of-way clearing was sub-contracted to timber cruisers. Their crews cut trees so as to leave the stump extending only four inches above the surface and the trees were so cut that they would fall in a position from which it could be moved with a minimum of labor.

Explosives experts would then be brought to the swamp and, with properly spaced shots of the correct grade of dynamite, it is possible to shoot out a trench of fairly uniform depth and width. The section of trench shot out may range in length anywhere from 500 to 1,500 feet. The shots may be fired consecutively or simultaneously.

An example of the speed and facility of this type of work may be gained from the report of a recently built swamp crossing. The crossing section was welded on the edge of the swamp and mounted on dollies. Immediately after the trench was opened tractors dragged the section into the ditch, where it was pulled backwards and forwards, causing it to bury itself slightly. A partial back-fill was thrown over it and subsequent high water completed the back-fill.

Blasting in swamps is common practice but in marsh country ditching with machines and laying with the aid of tractors is standard practice. Whenever necessary the ditchers are equipped with extension treads made of heavy planking bolted to the wheels. When the conditions are this extreme the ditchers are followed often with portable gasoline engine driven pumps. These are used to muck out the trench, throwing their discharge over the small coffer-dams ordinarily thrown up on both sides of the ditch.

Caving problems in such country are acute. If the ditch caves too badly near a bayou or stream bank the walls are shored up with timber cut near the job. Away from such extremities a special cutting blade attached to the digging wheel frame of the ditcher will cut a sloping trench and prevent caving.

Expertly used, blasting in the many rock sections has greatly speeded ditching in territory where it would otherwise be slow and costly. Charges sufficient to shatter the rock are used. Large power shovels or hoes follow in the wake of the blasting crews with their fleet of portable compressors, removing the shattered rock.

Most of the ditching difficulty in the Panhandle of Texas lies in crossing that part of the country which is cut up with

—Photo courtesy Ford Bacon & Davis Construction Company.

Erecting gas engine driven compressors in a pipe line station.

small canyons with steep walls and in traversing the Cimarron river bottom.

Because of the absence of ample transportation facilities in some sections of the State stringing costs in those areas may mount. On occasions it has been necessary to haul pipe as far as fifty miles. Moreover, the haul traveled over rugged country, necessitating light loading of the trucks and trailers to prevent their turning over. In most of the swamps and marshes oxen or teams of mules are used to "snake" the pipe to the job and, in the mountainous country, a winch-equipped tractor or truck "snakes" the pipe up or down steep inclines.

Ditching in the sandy wastes of the West Texas desert country is difficult because of the shifting sand. Machinery is used, but its progress is retarded and the motors run hot because of the excessive heat and hard work they perform. It is practice in the desert country to work with close operating "spreads." The laying gang follows immediately behind the ditching machine and the back-fill gang works close behind the laying gang. Even then it is not uncommon for the wind to blow the cover off the line. However, in a short while the wind is just as likely to blow a cover of several feet thickness over the line.

In most sections of the state ditches are cut to a depth sufficient to get below plow depth on lines up to ten inches in diameter. In the Panhandle they are laid at a greater depth to get below the frost line. On an average an eighteen-inch covering is put on lines up to ten inches in diameter, while on the larger diameter lines, a twenty-four to thirty-six-inch covering is specified.

On some of the larger diameter lines it has been practice to lay the pipe on skids over the trench with three slack wallops per 1,000 feet of pipe. This provides about twenty-four inches of slack per mile. If the stiffness of the pipe prevents looping on skids over the ditch some form of expansion joint is used to take up the contractional stresses.

Due to the varied soil conditions found in Texas, corrosion problems are numerous and the character of the terrain in some sections makes it difficult to apply coatings. In the rock areas the coated lines have to be lowered carefully to prevent ripping the protective coating from the pipe. In the swamps, marshes and wet fields it is often a problem to keep the pipe free of mud and moisture just prior to painting. Numerous "hot spots" that are a constant source of trouble are found on various lines.

Tractor buried in East Texas mud.

Some of the most modern methods in stream crossings have been developed in Texas during the past few years. These include a tunnel under a ship channel and the erection of numerous bridges. Some of the rivers in the State are difficult to cross with lines, because often the current will change its course and, in doing so, may uncover the line buried in the bed at that point. Later a tree or log may be plunged into the line with disastrous results. Along other rivers the banks will wash in sections weighing tons. Should this happen at a river crossing approach the line is usually carried away.

Some time ago the Lone Star Gas Company pioneered in bridge construction and since then numerous pipe line bridges have been built. The bridges have proven successful and from an operating standpoint they are far superior to the submerged type of crossing because the line is always accessible for maintenance.

—Photo courtesy Ford Bacon & Davis Construction Company.

River crossing approach cut out by high water.

In the Gulf Coast area the Sinclair-Prairie Company, built a tunnel beneath the Houston ship channel and has all of its channel crossing lines running through the tunnel.

On recent jobs where a submerged type of crossing was used, explosives were utilized to blast out a trench in the river bed.

The most trying country to cross with a pipe line is perhaps East Texas. Should a line follow a route cutting through the large field it would have to cross somewhere in the vicinity of 1000 lines. The great producing area covers a wide area and is criss-crossed with hundreds of oil, gas and water lines. In addition to having to cross the network of lines East Texas has its share of marshes to add to the difficulties.

Heaving Shale Formation Is Texas' Most Difficult Drilling Condition

By WARREN L. BAKER

THE various oil producing districts of the gigantic State of Texas probably present the most widespread variation in drilling conditions to be found in any one State of the Union. Producing depths vary from among the shallowest fields to commercial producing depths surpassed by only one well in the world; oil is obtained at a depth of twenty feet in some parts of the Yates pool, while in the Big Lake field, the deep oil bearing horizon is found below 8500 feet. Much of the oil in Texas has been found at comparatively shallow depths, but recently, however, a great deal of new production has been discovered at depths which place it in the category of deep drilling.

Formations penetrated in reaching the different oil-bearing stratas in Texas range from soft, cavey natures to hard rock, and from conditions which permit unusually fast drilling to peculiar and troublesome influences that frequently cause interference with drilling operations. Pressures encountered in Texas drilling also show an extremely wide variation.

Collapsible Drilling Bit used by Loffland Bros. This photograph shows blades in cutting position. When weight is taken off the bit the blades drop downward, making their circumference the same as that of the body.

Under these dissimilar conditions, drilling activities are conducted with practically every conceivable boring machine and device, and these factors, combined with some of the unusual problems encountered, have resulted in the advancement of important drilling technique.

At the present time, the State is accounting for nearly one-half of the drilling activity in the United States. The actual cost of drilling depends primarily upon the depth of the well, but it should be remembered that even though the average cost of drilling in a given locality is well established, the drilling of one particular well may cost anywhere from 50 to 100 per cent above this figure.

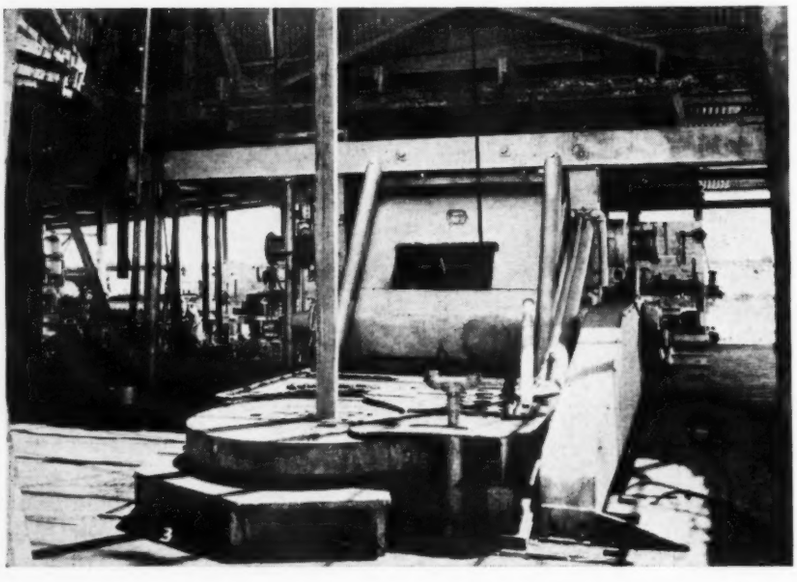
Future Prospects for Drilling

Although oil producing fields have been found in almost all parts of the State, it is quite evident that the present productive territory does not define the area of production in Texas, and that important extensions will be made. This opinion is influenced by the expansion of activity and production within the State during the past three or four years.

The State's immediate future is exceptionally bright, it has more actually discovered but undeveloped fields than any other state. The majority of these developments are suspended pending the completion of the drilling campaign in the East Texas field. From all indications, it is apparent that Texas should be the most active state in the country for a number of years.

At this particular time two districts seem likely to be the scene of the next big drilling campaigns. These are the Gulf Coast and Southwest Texas areas. The former is now attracting much attention due to the new Conroe field in Montgomery county. Although the exact extent of this field is still unknown, it appears to have very good prospects of becoming a prolific pool. In Southwest Texas, the Government Wells field of Duval county has received a number of important extensions, that together with a new pool in Bee county, and scattered smaller strikes, has created much interest in this sector of the State.

A most important factor in the future prospects of the State has been the finding of deep production, especially in the West Texas, Southwest and Gulf Coast regions. These districts are expected to play an important part in future drilling operations, which should extend to much greater average depths than in the past. Shallow drilling, however, will in all probability continue to claim the attention of the small operator.



Heavy Rotary Equipment on a wildcat near Goliad, Texas. Note unusually large amount of floor space between extremes of hoist and the corners of the derrick.

Heaving Shale a Difficult Drilling Problem

One of he most interesting and perplexing drilling problems found in the industry is that of making hole and setting casing in the heaving shale formation, a very peculiar horizon fre-

quently encountered by test drilling in the Gulf Coast, Southwest and West Texas areas. It is a heavy, compact shale that is very troublesome because of its great tendency to cave into the hole. When it comes in contact with fluid it apparently assumes a swelling action which increases its caving characteristics.

The formation has for many years provided a most complex drilling problem, often caving in above the drilling bit so tightly that it is impossible to extract the bit from the hole, or when the drill pipe string is withdrawn to run casing (a necessary operation if caving is to be prevented) the hole often fills up to such an extent that the casing string cannot be landed on bottom.

As a result, many strings of drill pipe and casing have been lost on account of the heaving shale "freezing" before they are either withdrawn or set at the desired depth. Contractors and operating companies have tried many methods of overcoming the obstacles presented by this horizon, including drilling through it while holding high pressures on the formation, the use of different gases in attempts to hold the formation in a solid form until casing can be set through it; and efforts have also been made to freeze it into a solid mass.

New Heaving Shale Drilling and Casing Method

Recently, a most interesting and successful means of setting casing in the heaving shale formation was used by Loffland Brothers, drilling contractors, on the Parks No. 2 well of the Plymouth Oil Company, about five miles from Goliad, Goliad county, Gulf Coast district. The job has attracted much attention from contractors familiar with conditions encountered in the heaving shale zone.

Heaving shale in this well was successfully penetrated with an ordinary drill bit and drill stem, but when the drill stem was withdrawn, the shale filled the hole so completely that the casing string could not be run through the horizon. The contractors realized that some new method would be necessary if successful completion of the well was to be accomplished. It was needless to redrill the hole by the ordinary method, since the shale would merely refill it each time.

The contractors decided that it would be exceedingly beneficial to devise a method whereby the casing could be "carried" while drilling the hole. With this thought in mind, they purchased an especially strong casing string and a collapsible blade drilling bit, with the idea of using the casing as a drill stem until the desired casing point was reached, then to extract the bit up through the interior of the casing without moving the pipe.

A special wire line collapsible blade bit, such as was desired to perform the operation, was obtained from the Reed Roller Bit Company at Houston, Texas. The feature of the bit was its collapsible blades, which permitted it to be extracted from the hole without removing the pipe. This was accomplished by means of a wire line attachment.

This bit head was screwed on and welded onto the lower end of the 8⅝-inch Grade "D" external upset to 9⅝-inch casing string, obtained on a special order from Spang, Chalfant & Company. The next six joints of pipe above the bit head were also screwed and welded together.

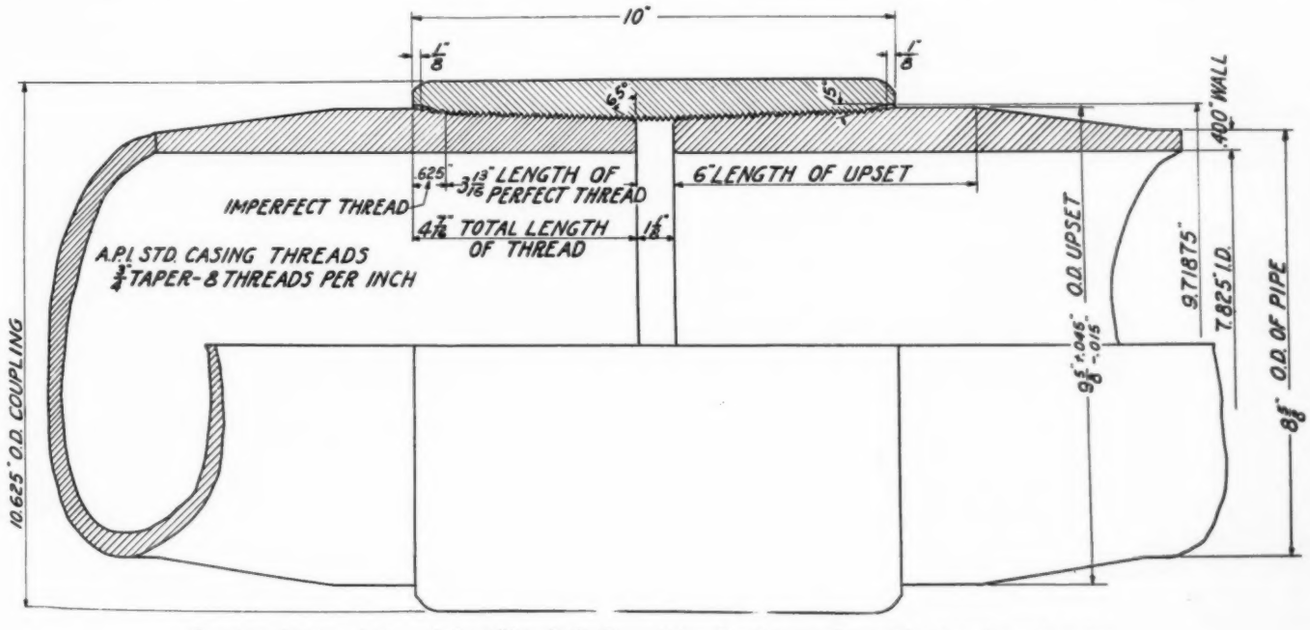
It will be noted from a study of the accompanying drawing showing the design of the casing upset, that it was made to resist torsional strain and that the thread was made somewhat longer than reguler 9⅝-inch A.P.I. casing. The length of the couplings was also increased over that of A.P.I. standards to accommodate the greater thread length, and they were recessed similarly to drill pipe couplings.

The upset casing string was first used as drill pipe, and then after penetrating through the shale to the desired depth, was set and cemented as casing, without ever being withdrawn from the hole. A feature of this operation was the fact that the pipe was continuously carried down, a condition that made it unnecessary for the contractors to worry about the amount of heaving shale that was caving, as it was always held behind the pipe string. Employment of this method makes the drilling of a hole in the heaving shale and running of the casing string through the formation but one operation.

About 600 feet of heaving shale formation was encountered in the well between 4200 and 5000 feet. The special bit and casing string was run into the previously drilled hole and had drilled out all the cavings to a depth of 5144 feet in one week and four hours. The blade carrier body assembly and blades were successfully recovered up through the casing string and the well was ready for cementing operations. Six hundred pounds pump pressure was maintained during drilling to keep the 10.2-pounds-per-gallon mud circulating.

Heaving Shale Slush Pump Pressure Difficulty Overcome

The heaving shale formation sometimes caves in so rapidly that it even stops the slush pumps, and for this reason it is frequently referred to as the South Texas pressure horizon.



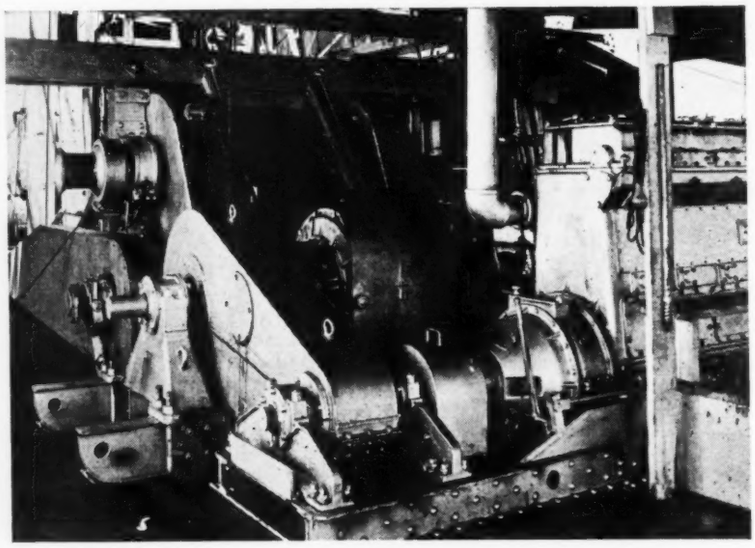
Drawing showing design of the 8⅝-inch O. D. x .400 wall x 36-pound special external upset casing

Naturally, when this condition is encountered, a tremendous back pressure is placed on the pump head, sufficient in many instances to cause serious damage to the pumps. It is, therefore, quite interesting and an important forward step that this difficulty has been overcome in a very simple and yet highly effective manner.

Herndon Drilling Company, Tulsa, Okla., contractors for the Stanolind Oil & Gas Company on a test near Mertzon, Irion county, rigged up rotary equipment at 6400 feet, at which depth the cavey shale formation was giving them much trouble and resulted in several fishing jobs.

The rotary equipment installed is quite interesting, being a mechanical drive with Diesel engines as power. The hook-up used is quite simple and direct, two drive chains from the power takeoffs of the engine operate the entire rig, one chain goes to a clutch and the other to a gear box. The reversible clutch is located five feet from the drive shaft of the draw-works and the engine five feet from the clutch, while the pinion on the gear box that drives the two 7¾ x 18 slush pumps is set only seven feet from the power take-off on the engine, making a very compact setup.

The engines are Type L eight-cylinder (in line), 265-horsepower, 700 r.p.m. solid injection Fulton Iron Works Diesels. The power takes off from a Twin Disc clutch from the flywheel of the engine to the shaft, carrying the sprocket through a flexible couplings. The sprocket is mounted between two roller bearings with the bearing supports bolted to the skids of the engine. The reversible clutch is new in design, in that it is operated by Twin Disc clutches in both forward and reverse positions. It is 480 horsepower. Another feature is that the operation of the reversing lever is optional, as on a steam rig. This is convenient on fishing jobs, with the reverse lever close to the throttle wheel.



A view of the draw-works hook-up on the Herndon Drilling Company's Diesel Powered Rig

While engaged with one of the fishing jobs it was necessary to raise the pump pressure to 2800 pounds in order to establish circulation. With the above described engines and pumps this was accomplished very quickly and circulation was returned, but had this not been true considerable damage to some of the equipment would doubtless have resulted. So, in order to prevent such damage, Lee Carpenter of the Lucey Products Company secured some Black, Sivalls & Bryson blowout heads and installed them on the discharge line ahead of the tee to the stand pipe in the derrick. This position allowed the pipe to emerge from under the flooring in the direction of the slush pits. A gate valve was placed just back of the blowout head to permit replacement of the discs without shutting down the pumps.

The original relief or blowout heads were equipped with discs (.040-inch thick) to relieve at 2000 pounds pressure. These blowout heads are similar to the improved type used on high pressure oil and gas separators. Two of the .040-inch thick discs were blown out and were later replaced with discs of .045-inch thickness, that were to blow out at 2600 pounds pressure. New discs may be economically and conveniently installed in these blowout heads, and it is believed that, in the foregoing instances, they have saved much trouble and damage to the pumps.

The use of the combination drilling and casing setting method and employment of blowout heads on slush pump discharge lines will probably be of wide significance in future deep drilling operations, especially where cavey formations and high pressures are found.

Rotary Drilling Mud Problems

Rotary drilling mud is a problem of major importance in several portions of Texas, largely because of the frequent encountering of caving and heaving shale strata and the necessity of penetrating through shallow formations carrying large volumes of high-pressure gas.

In the Gulf Coast area, the soft cavey formations demand that the operators increase the concentration of gel-forming colloids so as to seal up the wall of the hole and not permit penetration of mud or water into the formation. Upper gas pressures also demand a heavy weight mud to prevent blow-outs.

In West Texas upper gas pressures and loss of circulation are serious problems. The native clays are usually unsuited for drilling mud and admixtures of commercial clays are used, while the loss of circulation in the porous shallower horizons adds to costs. The first essential characteristic of a drilling mud for tests in this region is that it be heavy.

The Hendricks field of Winkler county was particularly troublesome to operators because of the large volumes of high pressure gas at relatively shallow depths and the appearance of porous sub-surface formations that absorbed much of the drilling mud, which uniformly had to be conditioned by admixtures of weight materials.

Straight Hole Drilling

Another important consideration is that of straight hole drilling. This practice is more important in some areas than in others, because of the geological nature of the pool.

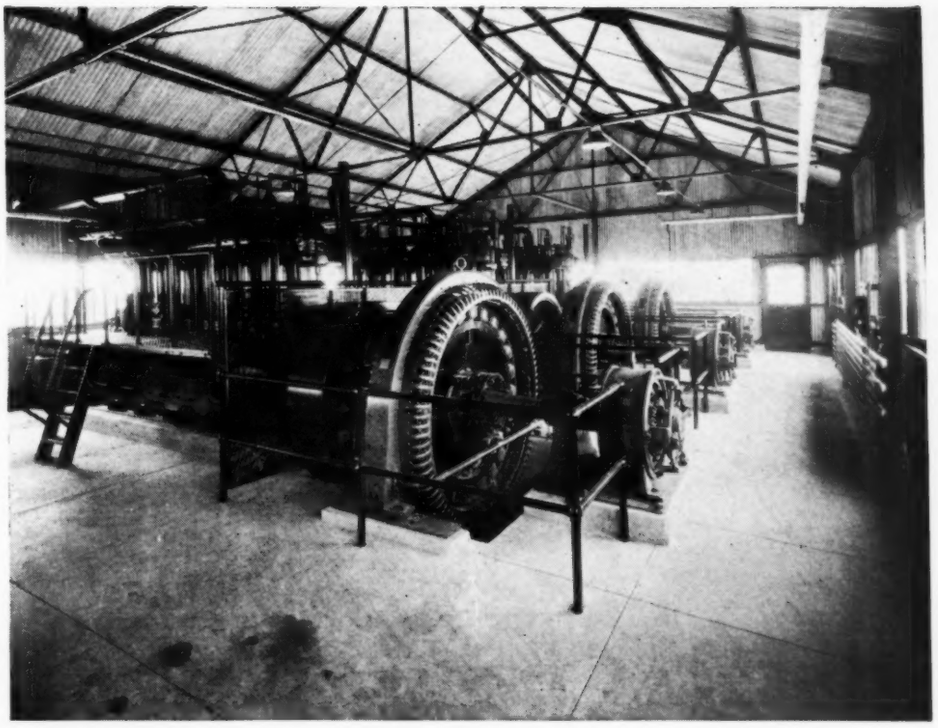
In the Gulf Coast fields it is quite important that straight holes be drilled, due to the small area generally covered by the producing region of salt dome fields. The general practice of surveying for crooked holes was introduced in 1928 and has become more widespread since that time. The principal advantage gained is the near-elimination of dry holes in proven territory, since straight hole drilling prevents the wandering of the hole from vertical to such a degree that it misses the producing reservoir.

Straight hole drilling is also very important in the fault fields of Southwest Texas and East Central Texas. Steep dips are frequently found in the sub-surface formations and these increase the tendency of the drill stem to deviate from vertical, so much so that contractors watch the course of the hole very carefully.

In the Van field of Van Zandt County, all drilling contracts carry the stipulation that holes are not to vary over five degrees from vertical. Measurements of the hole-course are taken every 400 feet.

Operating Problems on Texas Pipe Line Systems

By J. H. DAMERON



WITH their thousands of miles of pipe lines and hundreds of stations transporting companies are constantly confronted with a changing assortment of knotty operating problems. Practically all types of crudes from the corrosive sour oil to high viscosity crudes are pumped through the oil lines. The high pressure gas transmission lines offer their difficulties and the gasoline lines have brought about the development of several new operating features.

Following the development of enormous natural gas reserves in the Texas Panhandle, millions of dollars were invested in transmission arteries originating in that area. To operate these lines some of the most modern gas line compressor stations were built. One of these is the largest gas engine-driven compressor station in the world, having a rating of 15,000 H. P.

This station was erected at Fritch, Texas, by the Natural Gas Pipe Line Co., of America. It is the initial station on the combination coupled and welded 24-inch line to Chicago, Ill., designed to deliver 175,000,000 cubic feet of gas daily. The line is operated at a pressure considerably above that of the average transmission system. The main line units of the station consist of twelve 1,250 B. H. P. 24-inch by 36-inch horizontal twin tandem, double acting, four-cycle gas engines directly connected to the compressor cylinders. These units are housed in a 36-foot by 336-foot structural steel building. Generating equipment, including the three 420 B. H. P. six-cylinder, vertical gas engines connected to the generators, air compressors and machine shop equipment are housed in a 36-foot by 126-foot structural steel building.

The immense size of the station as well as the investment required to build and operate such a system may be more fully appreciated from additional facts. The large cooling tower dimensions are 17 feet by 180 feet by 48 feet and 7 inches. Permanent storage consists of 9,000 gallons of steel storage for lube oil; a 100,000 gallon domestic water tank and a 55,000-barrel steel water storage tank. In addition to the office and community hall building there are five 7-room houses; two 5-room boarding houses; two 5-room cottages; twenty-three 4-room cottages and four 14-car garages.

One of the most interesting operating features of the Fritch plant is the refrigeration process for the removal of condensable vapors from the gas. Because of the high pressure under which the line is operated it is necessary that all condensable fluids, at line temperature and pressure, whether vapor or any of the hydrocarbons, be removed.

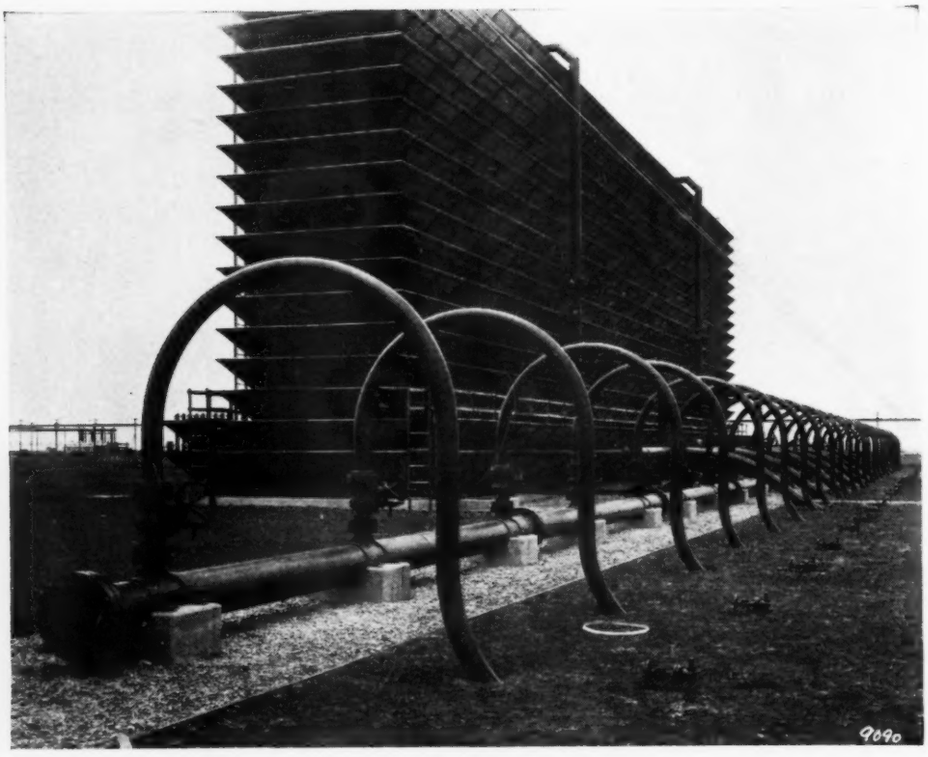
To accomplish this a refrigeration process is used. Gas from the field gathering system is compressed to the pressure to be carried in the main line. At this pressure it is passed to the gasoline plant absorbers and the natural gasoline is extracted. The gas is then passed to the refrigerating equipment which causes certain quantities of water vapor and condensable hydrocarbons to be dropped out of the gas into drips. The equipment for the process consists of four gas to gas exchangers, four propane to gas exchangers and the eight drips which collect the condensate removed from the gas as it passes through each heat exchanger. During this process the gas temperature is lowered to 40 degrees F. From the refrigerating process the gas goes on into the main line.

One of the most interesting lines in the state is the Phillips Pipe Line Company's eight-inch welded gasoline system, originating in the Panhandle and terminating at St. Louis. Stations on this line are equipped with butane fueled gas engines driving centrifugal pumps through speed increasing gears, the first installation of its kind used in pipe line operation.

Various grades of refined products, including liquid butane, blending naphthas and stabilized natural, are pumped. These products are blended to specification motor fuel at the several terminals equipped for blending the grades of motor fuel marketed by the company, including Ethyl gasoline. The different grades of products are "slugged" through the line during the more than a year of operation and no trouble has been experienced from contamination of products.

Butane, the otherwise waste product of most natural gasoline plants, becomes a liquid under pressure. As a liquid it is pumped through the line in batches. Each station operator runs a sufficient volume to station storage as the "slug" of butane is pumped through the station. It is then used as fuel, first going through regulators to drop its pressure and reduce it to vapor. Carburetors on the gas engines are adjusted to obtain the proper air-butane mixture for engine fuel.

Many of the newer stations erected in Texas embrace the most modern developments with full basements, ample lighting facilities and features in design making for easier opera-



tion and lower maintenance. The most elaborate stations are perhaps those on the Pure-Van Pipe Line Company's line from the Van field to Beaumont. These are brick stations, housing motor-driven centrifugal pumps. The station has an excellent piping layout and the interior is finished in attractive colors with part of the station finished with glazed tile. Machinery is neatly painted and some parts are chome plated. The station's offices are enclosed with plate glass windows that effectively shut out pump room noises and afford the operator complete vision of the pump room from the office. All of the control equipment is of the latest type and the units are equipped with automatic protective devices.

In many sections of the state the pouring of foundations for units and buildings is fraught with obstacles. Some locations may be in quicksand or loose soil formations, necessitating the driving of piles and building mats. Others may be in low sections that are not only hazardous to foundations, but must be diked to prevent flooding during high water periods.

The various grades of crude have freighted operating departments with an unusual number of problems. In the West Texas area crude with a high sulphur content has taken a toll of human life as well as a huge sum in corroded pipe line equipment.

Sulphur gas in the vapor space of a station storage or working tank often caused rapid corrosion to the under side of the tank roof. In some instances it corroded the metal fairly uniformly without breaking through to give warning of the weakened plates. Gaugers or others on the tank have fallen through the corroded plates in some cases and plunged to their death in the sulphur gas-filled vapor space.

To combat such hazards several companies adopted safety measures that prevented re-occurrences of such accidents. On one system two men are sent to gauge. Both are equipped with gas masks and the man doing the gauging has a rope fastened to his belt. The other stands by as an observer, ready to render assistance in the event of an accident.

The pumping of this crude developed numerous mechanical problems at the stations where it was used as fuel for Diesel engine installations. The sulphur crude caused corrosion of the fuel lines, spray valves, fuel pump plungers and caused rapid liner and ring wear as well as contaminated crank case oil.

Ordinary methods of settling water out of the crude used as fuel by means of cone bottom tanks, failed to materially check the corrosive attacks of the oil. Special alloy metals were used to make certain engine parts and this method of attacking the problem prolonged the life of those parts.

Greater progress was made when the fuel oil was run through a centrifuge that removed the water and b.s. and permitted part of the sulphur gas in the oil to escape. An open-type machine is used for this purpose and it is housed in a well-ventilated building some distance removed from the station. In addition to removing the impurities mentioned the centrifuge removed the abrasive material in the oil, preventing it from reaching the fuel pump and engine cylinders.

Stations with motorized equipment did not escape the attacks of the sulphur gas. Gas escaping from the pump packing boxes sometimes reached the motors and caused corrosion. The condition was remedied by totally enclosing the motors.

Gathering and low pressure lines perhaps suffered the greatest damage to pipe lines. Corrosion in some of the fields is rapid and the bottom of the pipe is corroded through in a short time. The period of pipe service is extended by merely giving the pipe a quarter turn and the process is followed until it is impracticable to further use the pipe.

Originally it was generally believed there would be little or no trouble due to interior corrosion to the trunk lines transporting crude with a high sulphur content. This was based on the theory the lines would be full, the oil in constant motion and no free air would be present.

Recent inspections made on two lines indicate a serious menace to West Texas lines from interior corrosion. One line was cut in several places and each section cut revealed evidence of interior corrosion taking place on the bottom side.

One of the most numerous of the operating problems is pumping crudes that congeal at moderately low temperatures. Panhandle crude congeals at about 52 degrees and in most instances heaters are used to lower the viscosity. One company follows the practice of mixing natural gasoline with the crude. This practice resulted in the operating of the line to a volume near its capacity during the cold months. Evaporation losses are said to be low and the practice is followed by several companies.

Some of the wells in the East Texas area produce crude that congeals at about 54 degrees F. and many of the transporting companies experience considerable trouble with their high pressure lines during cold months.

Last winter one company found it advisable to run a scraper about twice a week in order to operate the line to capacity. In practically all instances the deposition of paraffin is a soft jelly-like granular substance uniformly deposited on the inside walls of the pipe.

So badly have some of the gathering lines been choked with paraffin that it was necessary to cut the line. This extreme condition is being successfully combatted by several companies by means of mixing solvents in the crude when

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lease tank batteries are gauged. When used as Diesel fuel the oil sometimes congeals in the fuel tank and traps small pockets of water. Later this water finds its way in the fuel line in slugs, causes the engine to miss fire and sometimes shut down. Heating the fuel and flushing the fuel lines and pumps by means of starting and stopping the engine with warm kerosene used as fuel has been the most successful method of preventing fuel troubles due to congealing oil.

The construction of the new lines out of East Texas brought about the development of two methods of design and operation new to oil transportation. Texas-Empire Pipe Line Company on its initial station in East Texas has two centrifugal pumps being driven by and through speed increasing gears by a single but powerful Diesel. The speed increasing gears are equipped with two high-speed gears. The engine is a six-cylinder, 1,200 horse power vertical unit and the pumps are multi stage line pumps designed to deliver about 55,000 barrels daily against 750 pounds pressure.

In the construction of a field station at Mexia recently the Stanolind Pipe Line Company installed a light-weight, high-speed Diesel engine to drive a centrifugal pump through speed-increasing gears. The unit was designed to pump 25,000 barrels daily and the total cost of the installation was $25,000 —one dollar per barrel of capacity. The engine is a 300 horse power unit at 700 R. P. M. and weighs about 33 pounds per horse power. It has been in operation for several months and has shown a low operating and maintenance charge.

A few years ago the Gulf Pipe Line Company developed the closed water cooling system for pipe line station work and which is so widely used at present. Extreme water conditions caused rapid scaling in the engine jackets. Treating costs were high and maintenance charges were excessive because of the frequency of cracked cylinder heads. The original cooling system at the station consisted of the conventional open storage and reservoir and overhead gravity feed tank.

The closed system used first consisted of a heat exchanger having ⅝-inch tubes and about 200 square feet of cooling surface, a small surge tank and a centrifugal pump. Only a small volume of water is required to fill the system. Jacket water was circulated around the tubes of the heat exchanger and water from the reservoir was circulated through the tubes. This method kept the water going to the engines at about 100 degrees F. and the outgoing temperature at about 130 degrees F.

The next important change in this method of cooling was in adopting the oil to water system. The heat exchanger was tied into the suction line of a pumping unit and the cycle of operation is similar to that of the initial installation. Oil was forced through the exchanger tubes by means of a small centrifugal pump bolted to an extended base place with the water circulating pump in the engine room. It was necessary to force the oil through the exchanger because head from the stock tanks was so low that pumps did not fill properly due to the increased friction caused by the oil having to pass through the heat exchanger.

Since then numerous installations of closed water systems have been made at Diesel engine pipe line stations. In addition to being a highly desired method of cooling jacket water the closed water system is more economical to build. In a paper delivered before the Mid-Continent Section of the A. S. M. E., F. E. Waterfield, Jr., showed the cost of a closed system to supply cooling water to one 300 horse power, two-cylinder horizontal engine to be $4,567.81. The cost was divided as follows and the system was constructed in January, 1930.

Tabulated Cost Data for Closed Water System

Item	*Cost*
Two 400 sq. ft. return pass, water to oil heat exchangers	$1,623.18
Lipe pipe	290.39
Valves, flanges and fittings	511.80
3x12 single-stage, horizontal, belt-driven centrifugal water pump	118.00
Pulley, belting, surge tank, supports, etc.	180.70
Thermometers, pressure gauges and water meter	105.92
Concrete work, miscellaneous material and incidental expense	306.79
Labor of Installation	1,440.03
	$4,567.81

Pumping Wells in Texas

By K. C. SCLATER

THERE are approximately 46,000 producing oil wells in the State of Texas. A close estimate reveals that of this number 35,000 are pumping wells and the remaining 11,000 are wells produced by flowing either naturally or by artificial means. Included in this estimate are some 7,600 wells in the East Texas field virtually all which, with the exception of about 200, are classed as flowing wells.

The aggregate daily production of all wells in the State is one-third of the average daily oil production of the United States. In terms of production per well per day it represents a daily average production per well of nineteen barrels. This is a relatively high well average when it is considered that oil proration regulations are in effect.

Of the 35,000 pumping wells in the state it is estimated that 75 to 80 per cent have gas engines or other engines of the internal combustion type as a source of power and the remaining 20 or 25 per cent electric motors.

As might be expected in such a vast area as that covered by the State of Texas a diversity of pumping conditions and pumping practices are to be found. To enumerate these conditions, practices and the various types of equipment in any detail is manifestly outside the scope of this article; rather will they be outlined in a very general way.

Wells are being pumped from the shallow depth of 350 feet in the Toborg field in Pecos County and from a depth of more than 5,000 feet in the Gulf Coastal region.

In many fields of the Gulf Coast unconsolidated sands make it almost imperative to use screen pipe or liners opposite the "pay" in wells in order to counteract sand trouble while the well is being produced.

In the fault fields of East Central Texas, which includes fields producing the Edwards Lime and those producing from the Woodbine Sand, large quantities of water have to be produced with the oil, resulting in pumping loads that necessitate individual pumping of wells.

In the North Central and the West Central Texas regions the average daily production per well is small and as the wells are shallow or only moderately deep many are pumped by jacks operated from central powers.

In most fields of the West Texas region, the arid sandy conditions that prevail necessitates extreme care in providing for the proper upkeep of surface equipment. Also, in certain areas, there is the problem of corrosion in the well and at the surface due to the high concentration of hydrogen sulphide in the gas produced with the oil.

In the Texas Panhandle region there is trouble from corrosion in some areas and the region as a whole is characterized by the prevalence of paraffin trouble, which is particularly severe in winter.

Production practice in the Powell field is typical of that of the fault fields producing from the Woodbine Sand. The average depth of the wells is 3,000 feet. Large quantities of water are now produced with the oil, which is of 36 to 38 degrees A.P.I. gravity. Water made its appearance not long after the wells started producing and the amount accompanying the oil gradually increased to such an extent that it was necessary to replace the prime movers first installed for pumping by others of greater horsepower. Both gas engines and electric motors are used for pumping in this field, and as might be surmised from the heavy loads, wells are equipped for individual pumping. Power was first supplied by gas engines of 25 and 30 horsepower and 15/35 electric motors. With the appearance of large quantities of water these were replaced by 40-H.P. gas engines and 25/65 electric motors.

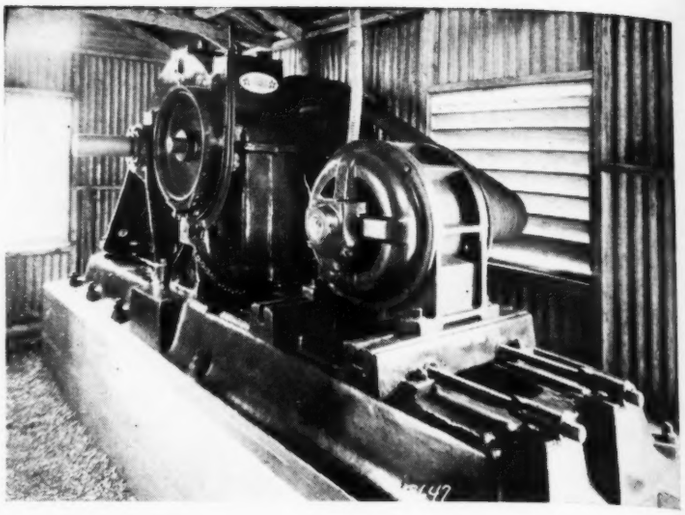
Long stroke pumps are in general use throughout the field. On many wells the long stroke is obtained by extending the length of the crank. From forty-two-inch to seventy-two-inch stroke and speeds of twenty to thirty-four strokes per minute are common, but the average length of stroke is from forty-two to fifty-four inches and a speed of twenty to twenty-five strokes a minute.

All wells are carefully counterbalanced. The grasshopper type counterbalance is in use on many wells. Bandwheel counterbalances are also in use. These are set at 180 degrees from the crank axis. By careful counterbalancing a reduction of fifteen to twenty per cent in the amount of power required is usually obtained.

Wells in the field have a high water-oil ratio and treatment of the oil is usually necessary. Separation of the oil and water is obtained by chemical treatment, the chemical being fed into the lead line from the well through a lubricator. The average lifting cost is eight cents per barrel of fluid.

In the Luling field, another fault field, production is obtained from the Edwards Lime from an average depth of 3,400 feet. The average gravity of the oil is twenty-seven to twenty-nine degrees A.P.I. Individual pumping is general in this field as also in the Salt Flat field. In the latter field production is also obtained from the Edwards Lime from an average depth of 2,700 feet. The average gravity of the oil there is thirty-six to thirty-seven degrees A.P.I. Although a large number of the wells are equipped with gas engines, there is a preponderance of electric power used in these two fields for pumping.

Hydrogen sulphide is present in the gas and there is enough to cause corrosion trouble and to make it necessary to exercise care in the use of pumping equipment, both in the well and at the surface. Tests made on a number of wells in Luling and Salt Flat by engineers of the United States Bureau of Mines showed a hydrogen sulphide content in the casinghead gas the amount of which in different wells varied from 0.4 per cent to 11.04 per cent. Several well-known makes of standard pumping units are in use in the field. The average lifting cost of the oil is about 20 cents per barrel.



In the North Central Texas region alone there are more than 14,000 oil wells and virtually all are being produced by pumping. Most of these are shallow wells and the average daily production per well is low, being only four barrels. Many of these wells are being pumped by jacks operated from central powers.

There are several fields in West Texas the pumping and operating conditions of which are of special interest.

The Big Lake field is best known for its deep oil wells that produce by natural flow, and contribute about two-thirds of the daily average production from the field. The other one-third of the production comes from the shallow sands at depths of 2,400 and 3,000 feet. There are 242 pumping wells that produce from these sands, and all produce some water with the oil. Records of the Big Lake Oil Company, which owns the most of the pumping wells in the shallow sands, show the ratio of water to oil produced is two and a half to one.

Bad water and a high concentration of hydrogen sulphide in the gas were responsible for the change from gas engines to electric power in this field. With the exception of ten wells in the 2,400-foot sand that are pumped from a central power, every shallow well in the field is pumped individually by electric motor. The major change to electric power was made in May, 1927. The high lines into the field carry 66,000 volts. The voltage is stepped down to 13,800 at the main transformer banks in the field, then to 440 volts at small transformer stations. The latter voltage is that carried in the distribution lines thence to the motors at the well. Electric motors of 15/35-H.P. are used throughout the field at the pumping wells. The low side is used for pumping and the high side for pulling and cleaning-out.

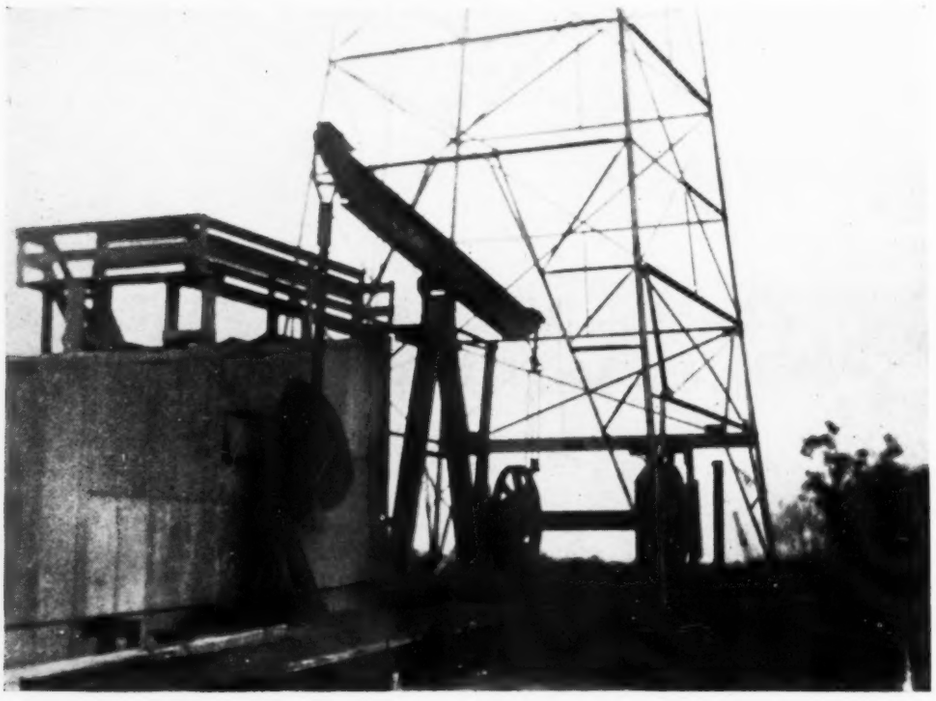
Power is transmitted from the motor to the countershaft and from the countershaft to the bandwheel by belt drive. A pumping speed of from twenty to twenty-five strokes per minute is maintained and the lengths of stroke used range from twenty-four to fifty-four inches. Two-inch and three-inch tubing with corresponding size pumps and valves are in use.

Several wells in the field that have an extra heavy pumping load due to water have motors with a rating of 25/65 horsepower.

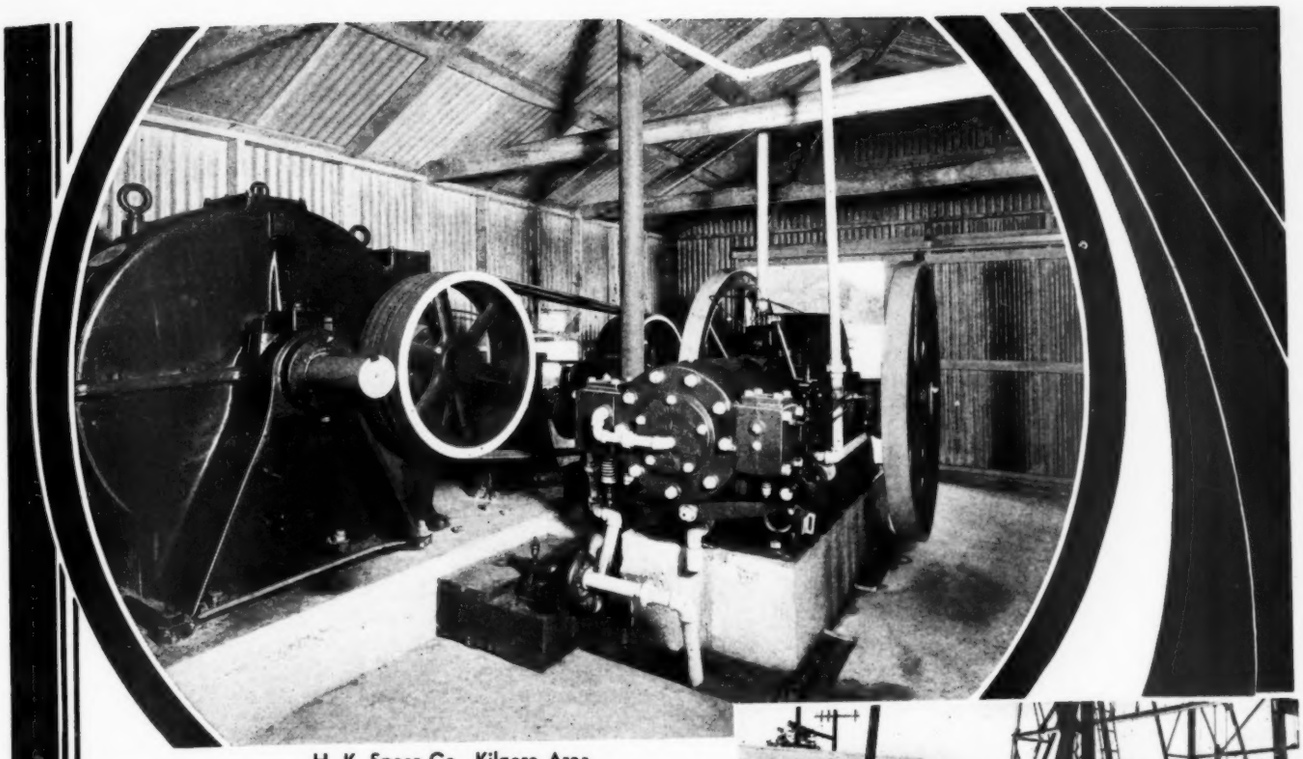
Only two companies operate in this field, the Big Lake Oil Company and the Group No. 1 Oil Corporation, the latter a subsidiary of the Continental Oil Company.

Of the total number of pumping wells the Continental Oil Company has more than sixty producing from the 3,000-foot sand. These wells are equipped with tex-rope drives between the motor and the countershaft.

The ten wells producing from the 2,400-foot sand are pumped from a central power and are operated by the Continental Oil



Pumping a deep well "on the beam."



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Cheap equipment is *temporary* equipment, meaning for low efficiency and heavy maintenance expense and short life.

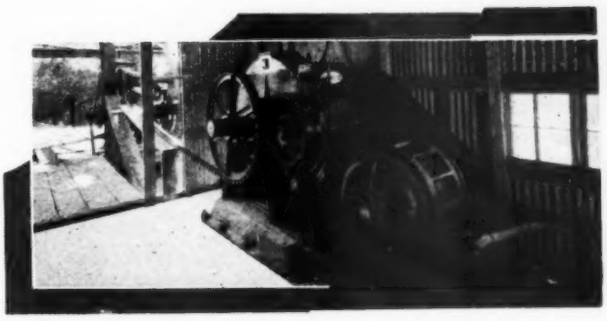
Lufkin Equipment is *efficient, permanent* equipment, meaning for long life, a minimum operating expense and in the long run, materially lower lifting costs.

Lufkin Units are manufactured in sizes to meet any pumping or well servicing requirement and are adaptable to electric, gas, oil, and steam prime movers.

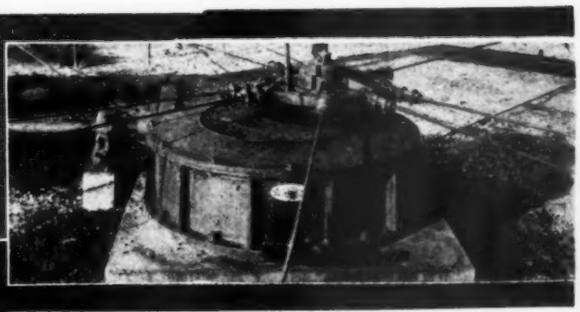
Twenty-one leading operators are using Lufkin Equipment on East Texas wells.

Write for complete details today!

Sun Oil Co., Walker No. 1, Gladewater Area.



Lide-Rowe Oil Co., Joiner Area.



Hunt Production Co., Joiner Area.

LUFKIN

FOUNDRY & MACHINE CO.

General Offices and Factory: LUFKIN, TEXAS

Branch Offices and Warehouses: Houston Tulsa Los Angeles

New York, Odessa, Seminole, Bakersfield, Eldorado, Henderson

Company. The power was installed about seven years ago. It is of the bandwheel type, having a twenty-four-foot bandwheel with twenty-eight-inch face and thirty-six-inch eccentrics top and bottom. An intreesting feature of this power is that it can be driven by gas engine or by electric motor. If anything happens to the engine the electric motor can be started up immediately or vice versa. To do this the gas engine and the electric motor are connected by a countershaft to the bandwheel driving pulley.

After the power had been in operation for about four years it was found that due to water the load as calculated from the power required at the wells had become too heavy. The gas engine, which is of the four-cycle type with a sixteen-inch cylinder and twenty-one-inch stroke and has a rated capacity of sixty-five horsepower, was running at 200 revolutions per minute, whereas its normal rated speed is only 150 revolutions per minute. It was carrying a load much in excess of its rated capacity. Wattmeter readings showed that the load was 104 horsepower when operating on the motor. To overcome this difficulty the setting of the engine was altered so that the engine could operate the bandwheel drive pulley direct, also the length of the belt drive was increased from fifty-five to sixty-five feet. This change was completed in March, 1931. Between the engine and the bandwheel driving pulley there is a straightaway clutch with roller bearings. The belt drive has twenty-two-inch seven-ply belts. The wells are equipped with three-fourth-inch sucker rods and operate at eighteen strokes per minute. Only one swing is used in the pull-rod line between the power and each well and there are no hold-ups or hold-downs.

A truck equipped with a small compressor and motor is in use for keeping the motor windings and other electrical equipment free from the accumulation of dust and sand. It is claimed that a saving in upkeep of twenty to thirty per cent in upkeep is made thereby.

Tests made on the gas in this field show that it contains about ten per cent hydrogen sulphide.

In the McCamey field similar tests show a hydrogen sulphide content of six per cent and in the Crane-Upton fields of from eight to twelve per cent. Corrosion troubles in these fields are among the most severe in the country and have a considerable influence on pumping practices.

Hendrick field, Winkler County, is another field in West Texas in which production is obtained chiefly by pumping.

Gas engines and electric motors are used as a source of power. Long-stroke pumping is general. Careful provision is made to protect the surface equipment from sand and grit because of the arid sandy conditions that prevail.

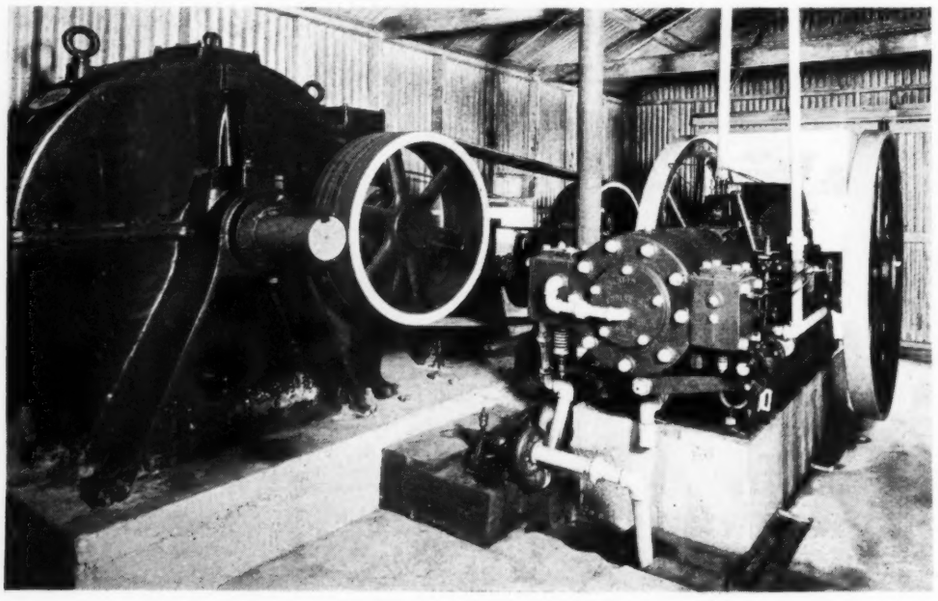
In the Lost Lake field on the Gulf Coast slow speed oil engines are used for pumping. Here the practice of pumping two wells with one engine is resorted to in the interest of economy. The engine is installed on the heavier well, which is pumped in the ordinary way on the beam; but the other well is pumped by means of a heavy jack operated by pull rods from the heavier well at which the engine is set. Wells in this field are pumped from an average depth of 2,800 feet. Between the engine and bandwheel power is transmitted by a twenty-two-inch belt. The engine pulley is sixteen inches in diameter with a twenty-two-inch face, and the bandwheel is twelve feet in diameter with a twenty-inch face. Fuel consumption when the daily production per well was 125 barrels was seventeen gallons per well per day.

Pumping equipment of the most modern design can be observed in the more recently developed fields. Much attention is being shown by operators in multiple pumping of wells. Where topographical conditions are favorable and the pumping loads not too heavy, consideration is given to this method of pumping. Central powers have undergone vast improvement in design in recent years.

For deep wells and heavy loads, or on wells where the load is likely to increase due to water encroachment, individual pumping is the most adaptable method.

Problems in well pumping in Texas now are overcome or their solution greatly aided by means of the dynamometer. By its use the variation in loads throughout the pumping cycle can be accurately ascertained. Investigation of the effect of rod and tubing stretch and their influence in the volumetric efficiency of the well pump is greatly facilitated. Advancements such as these in methods of attacking pumping problems have had a great impetus in the last few years because of the dire need for economy.

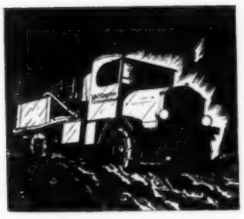
Many innovations in well-pumping practice are under investigation and many on actual trial in the Texas fields. Efforts are being made to reduce stresses in the pumping equipment in the well. Combination strings of sucker rods, slow-speed pumping and the use of pumps of small cross-sectional area are all in use in the State. The real advances in pumping methods that have been made will become more apparent when the industry returns to normal. Its multifarious fields are well recognized as an excellent proving ground for the latest types of pumping equipment of all kinds.



WHEN the newer Texas fields came in with such startling success as to command the attention of the entire country, the industry found, as usual, that Halliburton was ready to serve them.

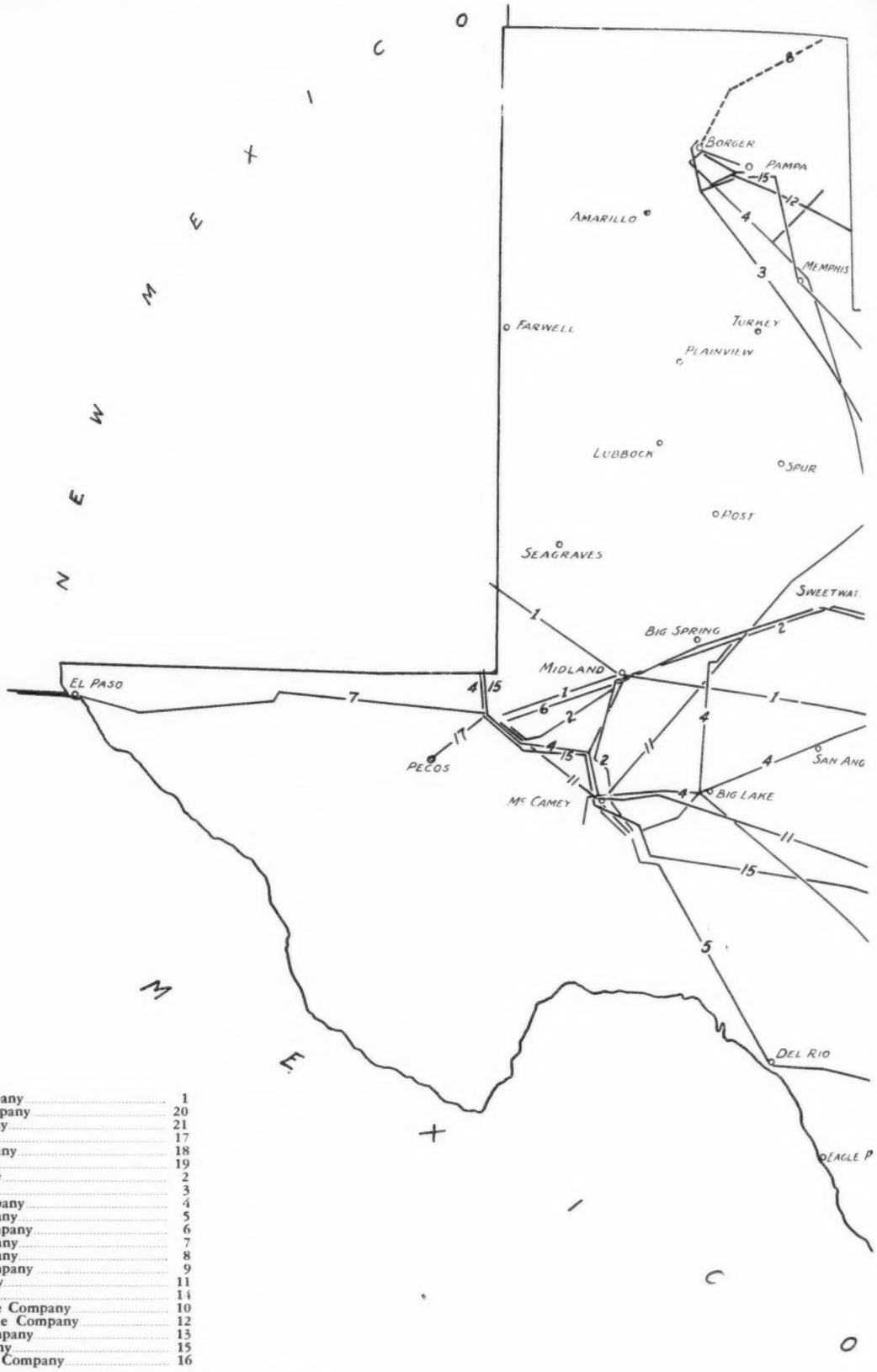
It was a tremendous job . . . one that required aggressive and alert attention 24 hours a day and seven days a week; but, thanks to organization and experience, it was accomplished without delay to anyone. On a single Sunday 62 wells were cemented in East Texas alone, and each received the same studied care and attention to detail as if it were the only job being handled that day.

As a result of this service, the life of the fields was lengthened, many serious dangers avoided and the yield multiplied. Just another demonstration of the value to the industry of organized responsibility!



HALLIBURTON
OIL WELL CEMENTING CO.
Duncan, Oklahoma

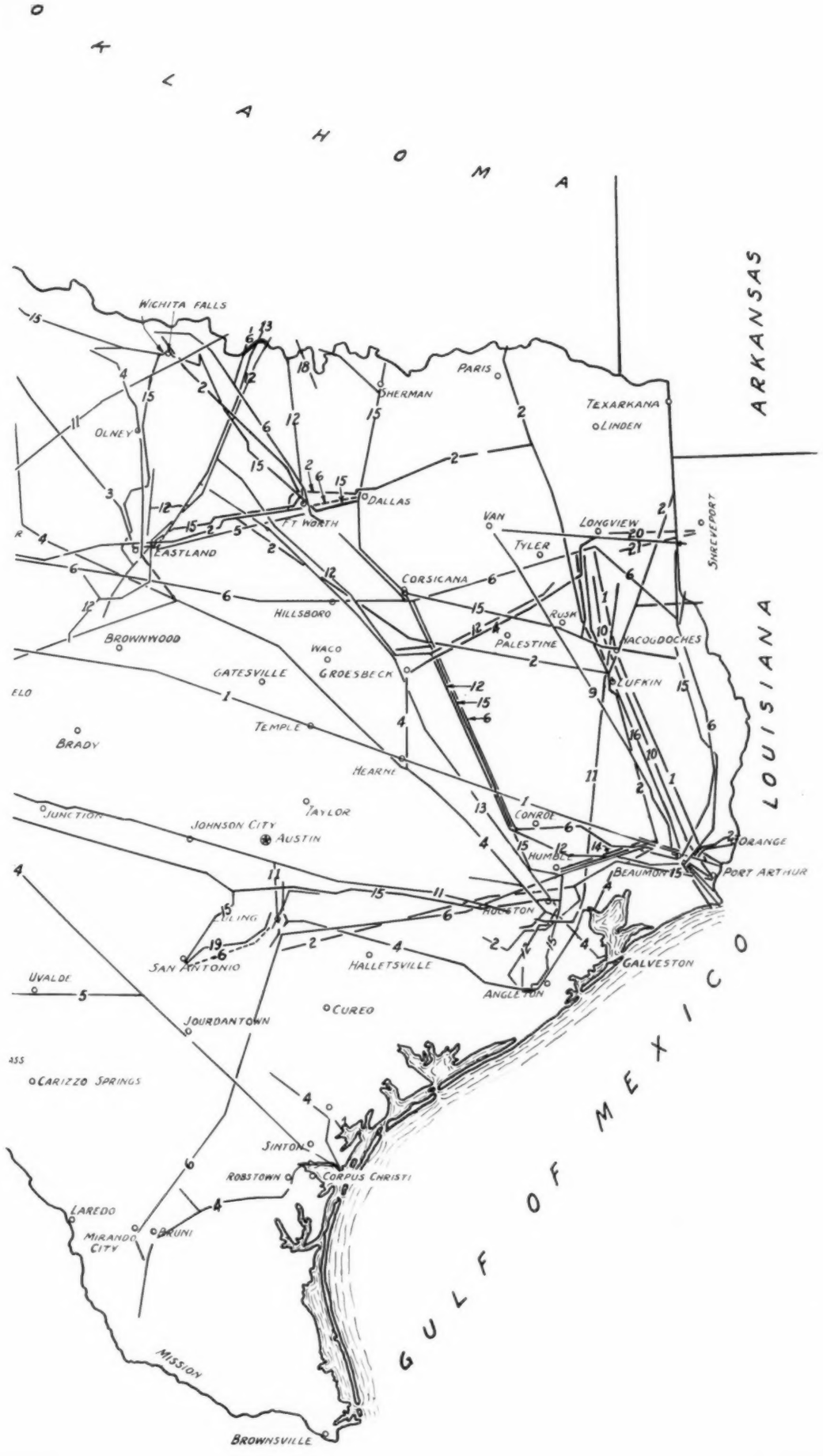
CRUDE OIL AND GASOLINE M



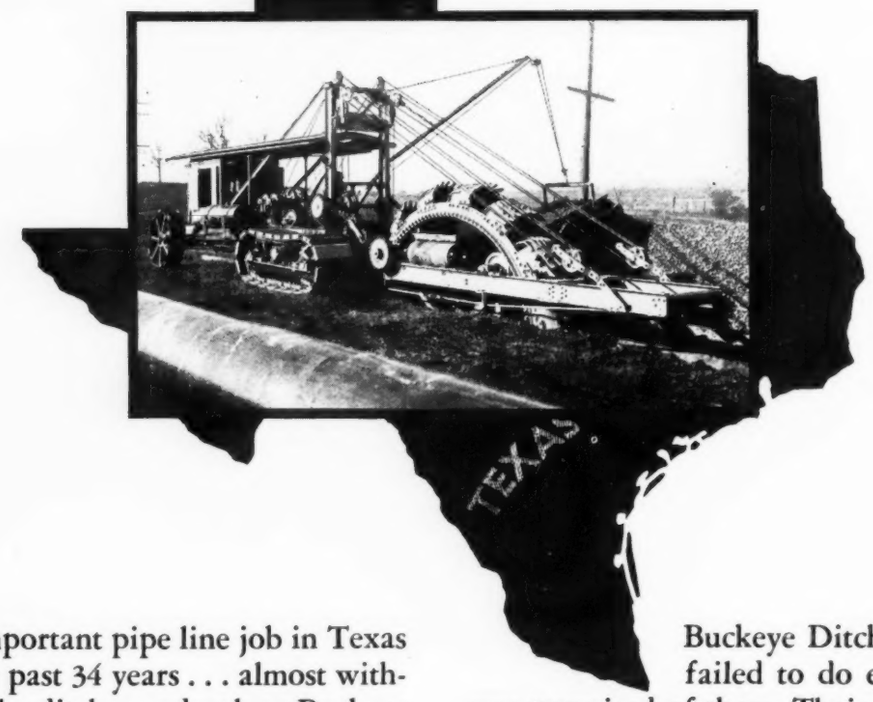
Atlantic Pipe Line Company	1
Arkansas Pipe Line Company	20
Atlas Pipe Line Company	21
Burford Oil Company	17
Empire Pipe Line Company	18
Grayburg Oil Company	19
Gulf Pipe Line Company	2
Gulf-Magnolia	3
Humble Pipe Line Company	4
Illinois Pipe Line Company	5
Magnolia Pipe Line Company	6
Pasotex Pipe Line Company	7
Phillips Pipe Line Company	8
Pure Van Pipe Line Company	9
Shell Pipe Line Company	11
Sun Pipe Line Company	14
Sun-Yount-Lee Pipe Line Company	10
Sinclair-Prairie Pipe Line Company	12
Stanolind Pipe Line Company	13
Texas Pipe Line Company	15
Texas-Empire Pipe Line Company	16

*Oil lines are solid, gasoline lines are broken.

MAIN LINE SYSTEMS IN TEXAS*



BUCKEYES
all over the state....



Check every important pipe line job in Texas laid during the past 34 years . . . almost without exception the ditch was dug by a Buckeye Ditcher.

Why? The answer is *performance* . . . the history of which is written in the profit figures of hundreds of Texas jobs.

Buckeye Ditchers never have failed to do even more than was promised of them. Their *world-wide* acceptance has this same explanation. They stick to their digging and finish with a profit . . . on schedule. Tell us the job you must do. We'll find a way to produce your ditching profits.

And their team-mate, the Buckeye OB $\frac{7}{16}$-yard Convertible Excavator is equally the master of conditions on a wide range of jobs. The Buckeye OB on any job means more dirt per dollar. In comparison, it's a $\frac{3}{8}$-yard investment, producing $\frac{1}{2}$-yard results. Let us send you specifications and bulletins. Then make your own comparisons.

THE BUCKEYE TRACTION DITCHER COMPANY
FINDLAY, OHIO, U. S. A.

Buckeye

TRACTION DITCHERS AND CONVERTIBLE EXCAVATORS

Corrosion Increases Problems of Tank Farm Maintenance

PROBLEMS in connection with the maintenance of the more than 150,000,000 barrels of steel storage capacity in Texas are more acute in the areas where sour crudes are produced than in any other section of the state. Because of its great production of sulphur crude and wide temperature variation, West Texas has offered numerous problems incidental to storing oil. Other regions in the state have more or less routine problems.

About one-third of the state's capacity is located in West Texas. That section has about 52,000,000 barrels capacity; the Panhandle 22,000,000 barrels; the Gulf Coast about 55,000,000 barrels and East Texas and North Central Texas each have about 10,000,000 barrels capacity. Only two concrete reservoirs of consequence are located in the state and both of these are 1,000,000 barrel capacity underground concrete tanks owned by the Shell Petroleum Company in West Texas.

In the early development of West Texas the sulphur crude and gas proved very destructive to much of the steel tankage. Most of the corrosion was found on the under side of the roof, the interior of the top rings of the shell not covered with oil, and on the bottom plates.

Some of the tank roofs went out of service in a very short time. Sulphur gas in combination with moisture caused rapid corrosion and soon after trouble was noticed on the tank roof and corrosion was discovered on the bottom plates.

Several methods were adopted to combat the corrosive attacks of the sulphur crude. A great many of the new storage tanks were built with steel shells and wooden roofs. Such a roof was covered with any of the several insulating materials such as galvanized iron, treated felts and tar paper. These methods served to alleviate the seriousness of the conditions appreciably.

Some of the companies painted the interior of permanent steel storage to prolong their life. In most of these instances it was necessary to thoroughly sand blast the surface in order to remove all of the tank scale prior to painting.

The bottoms of many tanks have been coated with manufactured material applied hot and which has given good results. The material is poured on the bottom plates to a thickness of about three-eighths of an inch. It dries rapidly and hard and prevents tank scale or sulphur water from reaching the bottom plates. To fully protect the plates the roof supports are jacked up and the material poured over those spots. When it dries the supports are lowered.

Soil conditions often cause corrosion to start on the tank bottom exposed to the tank grade. This type of corrosion more often results in small leaks around the rivets and which are detected by oil seepage or abnormal losses shown by gauges.

Spot welding and "patching" is the most frequent method used in repairing steel tankage, especially the bottom plates. The tanks are emptied and all gasses permitted to escape to the atmosphere. The bottoms are then cleaned and to get as much oil as possible off the bottom plates sand or cotton seed hulls are sprinkled over the plates. Either is swept back and forth across the bottom, absorbing the oil as it is brushed.

Either acetylene or electric welding is used for the repair work. Pit holes are brushed out and spot welded. If a plate is badly corroded a "patch" cut from sheet steel to the dimensions desired is welded in place.

Some trouble is encountered with water causing corrosion to start near the bottom of the first ring. In many instances tar paper has been used to make a mould so that a hot application of coating material could be applied to the bottom plates and sloped upward to above the water line on the first ring. The coating dries hard and prevents further attacks of corrosion.

At some tank farms experiments have been made with applying concrete to the bottom plates. The concrete is poured to a depth of four to six inches and the seam between the concrete coating and the shell is caulked. This method of protecting bottom plates has not been as successful as anticipated because the concrete cracked on several installations and it was necessary to go back in the tank to make repairs.

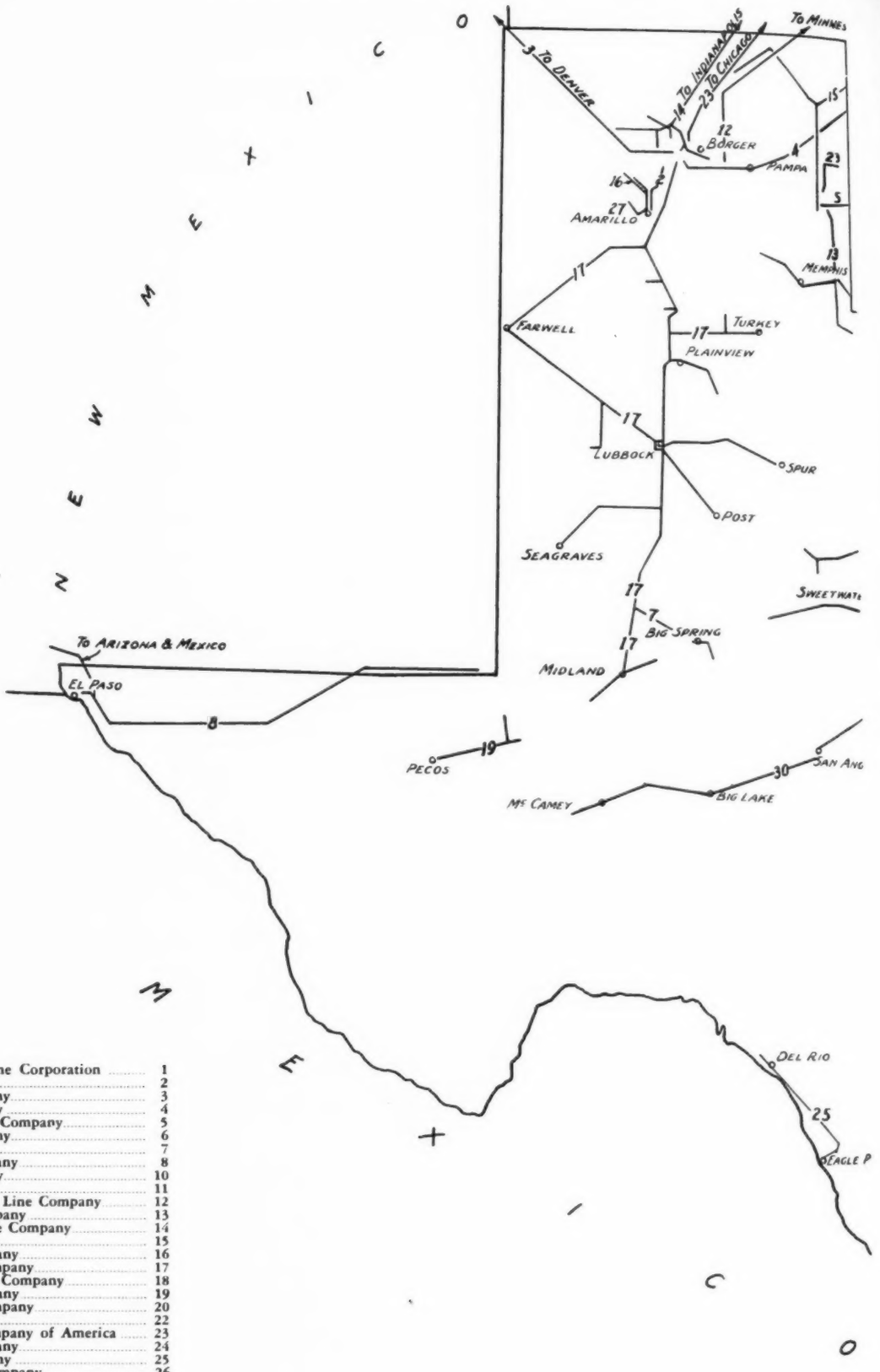
In recent years considerable study has been given to the proper painting of tanks to reduce evaporation losses, prevent rusting and improve the appearance of the tank farms. Most of the tanks now in service are painted a light color to reflect as much heat as possible and lower the temperature of the vapor space to prevent as much breathing as possible.

Aluminum paint has been used extensively as is aluminum foil. The foil is applied to the tank roof and held fast by using a suitable adhesive material. Both the foil and light-colored paints have aided materially in lowering the temperature of the vapor space in the tanks.

Fire protection at most of the tank farms consist of the conventional method of building a fire wall around each tank to prevent the spread of fire. Some of the farms are equipped to fight tank fires with steam while other storage points are protected by foam lines. Most companies keep a cannon on the tank farm to puncture the shell in order to drain oil out and prevent the tank from boiling over.

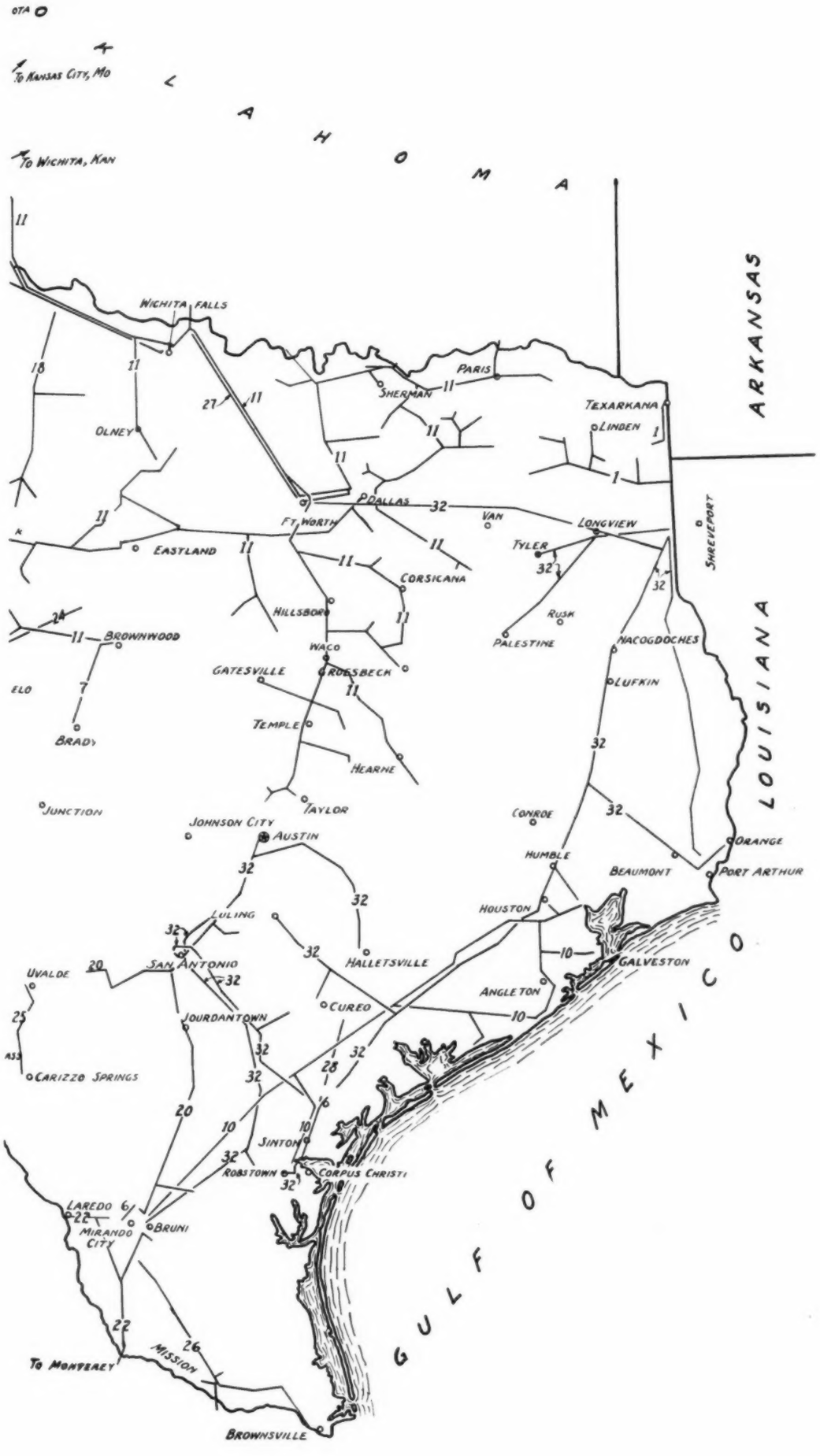
Gulf Pipeline Company Tank Farm in West Texas

NATURAL GAS TRANSMIS S



Arkansas-Louisiana Pipe Line Corporation	1
Amarillo Gas Company	2
Canadian River Gas Company	3
Cities Service Gas Company	4
Consolidated Gas Utilities Company	5
Carolina-Texas Gas Company	6
Empire Southern Company	7
El Paso Natural Gas Company	8
Houston Pipe Line Company	10
Lone Star Gas Company	11
Northern Natural Gas Pipe Line Company	12
North Texas Utilities Company	13
Panhandle Eastern Pipe Line Company	14
Public Service Company	15
Panhandle Pipe Line Company	16
South Plains Pipe Line Company	17
Stamford and Western Gas Company	18
Southern Union Gas Company	19
Southern Gas Utilities Company	20
South Texas Gas Company	22
Natural Gas Pipe Line Company of America	23
Texas Public Service Company	24
Texas Gas Utilities Company	25
Rio Grande Valley Gas Company	26
U. S. Government (Helium lines)	27
United Gas Company	32
Utilities Fuel Supply Company	28
Wheeler County Gas Company	29
West Coast Power Company	30

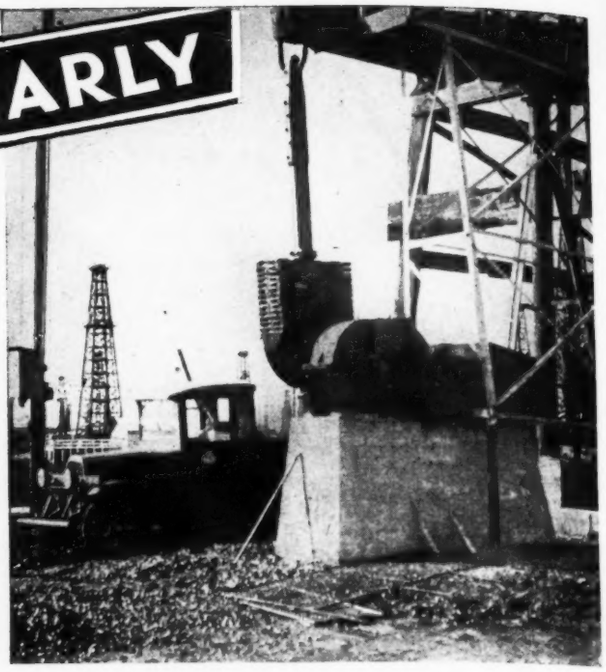
SION SYSTEMS IN TEXAS

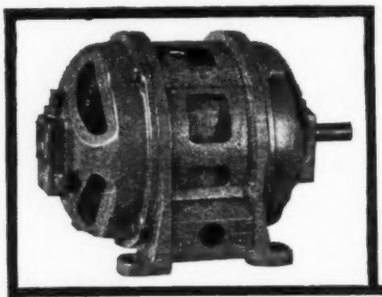


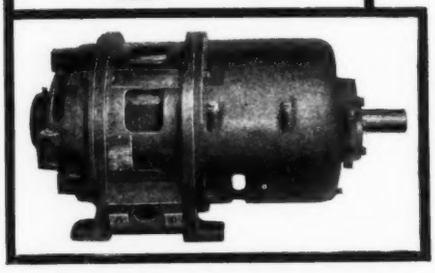
$1416 SAVED YEARLY

by

SLOW-SPEED ELECTRIC *Pumping* ON 94-BARREL WELL







Above—Westinghouse slow-speed electric drive on a beam well in California. The drive consists of a Line-start Squirrel-cage Induction Motor connected through V-belt to ODH Gear.

Left—Standard type CS Constant Speed Squirrel-cage Motor equipped with Sealed Sleeve Bearings for driving ODH Pumping Units.

The new Westinghouse Gearmotor is suitable for converting present drives to slow stroke pumping.

BY reducing the pumping speed on a certain 94-barrel well from 27 to 10 strokes per minute, power input to the motor was decreased from 13.85 to 7.2 horsepower. This saving in power consumption plus the reduction that resulted in labor and maintenance charges, gives a total yearly saving of $1,416. In addition, shutdowns due to mechanical failures were reduced by 84 per cent.

Slow-speed electric pumping has other advantages. There is a greater production of "clean" oil because less emulsification occurs—this reduces dehydration costs. There is less wear and tear on rig and below-ground equipment, and less shut-down time. Cost of equipment and materials also is lower.

For slow-speed pumping of *heavy producers* at high volumetric efficiency and low cost, Westinghouse offers the ODH pumping unit, complete with gears, motor, and control for pumping speeds as low as two strokes per minute.

Westinghouse oil field equipment is distributed by the Oil Well Supply Company and, with the exception of reduction gears, by the National Supply Companies, with offices and stores in all oil fields.

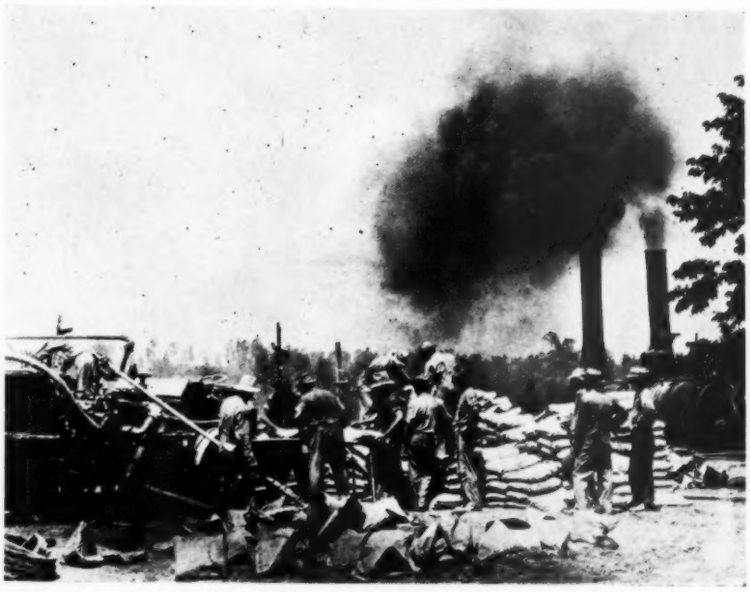
T 79274 **Westinghouse**

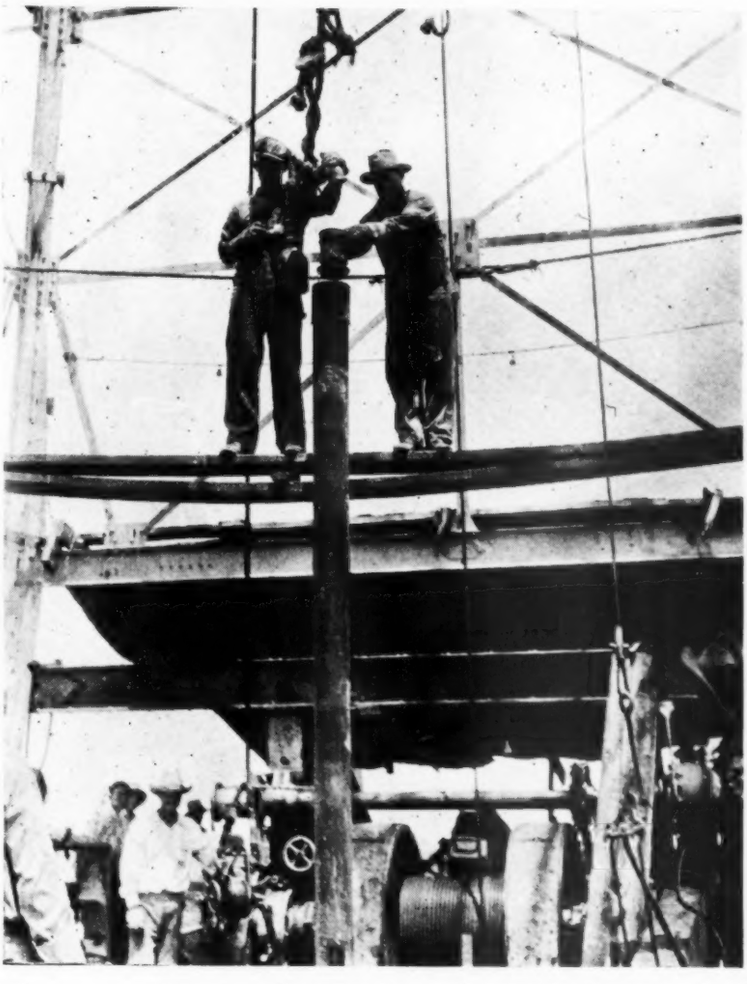
Quality workmanship guarantees every Westinghouse product

Casing String Cemented by Multiple-Stage Process

APPROXIMATELY 1,000 sacks of cement were securely placed behind the entire length of a 3,660-foot string of seven-inch (A.P.I.) twenty-pound seamless casing in a well in the East Texas field with a pump pressure that did not exceed 450 pounds. The well was the Steen Drilling Company's Loden No. 5 in the north end of the field in the Gladewater district.

Pumping the cement behind the casing to the surface in a well of this depth with a maximum pump pressure of only 450 pounds was made possible by using the Multiple-Stage cementing process, a description of which appeared in the March, 1932, issue of THE PETRLEUM ENGINEER. It was a two-stage cementing job whereby the cement was placed in two batches in one continuous operation. A Halliburton float shoe on bottom and a Multiple-Stage cementing tool set in the casing 2,140 feet off bottom, or 1,520 feet from the surface, were used to place the two batches of cement. The lower batch, consisting of 575 sacks, was placed behind the casing through the float plug on bottom, and the upper batch, consisting of 420 sacks, was placed behind the casing through the cementing tool at 1,520 feet.





Before starting to pump the cement, light mud was circulated for an hour. The lower batch of 575 sacks of cement was then pumped down the casing in the usual way and was followed by eighty-six barrels of water, with a special wooden plug placed between the cement and the water. This quantity of water filled the lower part of the casing between the float shoe and the cementing tool. Another special plug to open the cementing tool was placed on top of the water and then the upper batch of 425 sacks cement pumped down the casing. A wooden plug was placed on top of the cement and then was followed down by water. The downward progress of the plug was closely observed with a Halliburton steel measuring line. When the plug reached 1,515 feet, five feet above the cementing tool, the pumps were shut down. The total time taken in placing the cement was one hour and forty minutes. The maximum pump pressure of 450 pounds was reached just before the pumps were shut down. Pressure readings observed as the top plug was on its way down were: at 1,025 feet, 400 pounds and at 1,515 feet, 450 pounds.

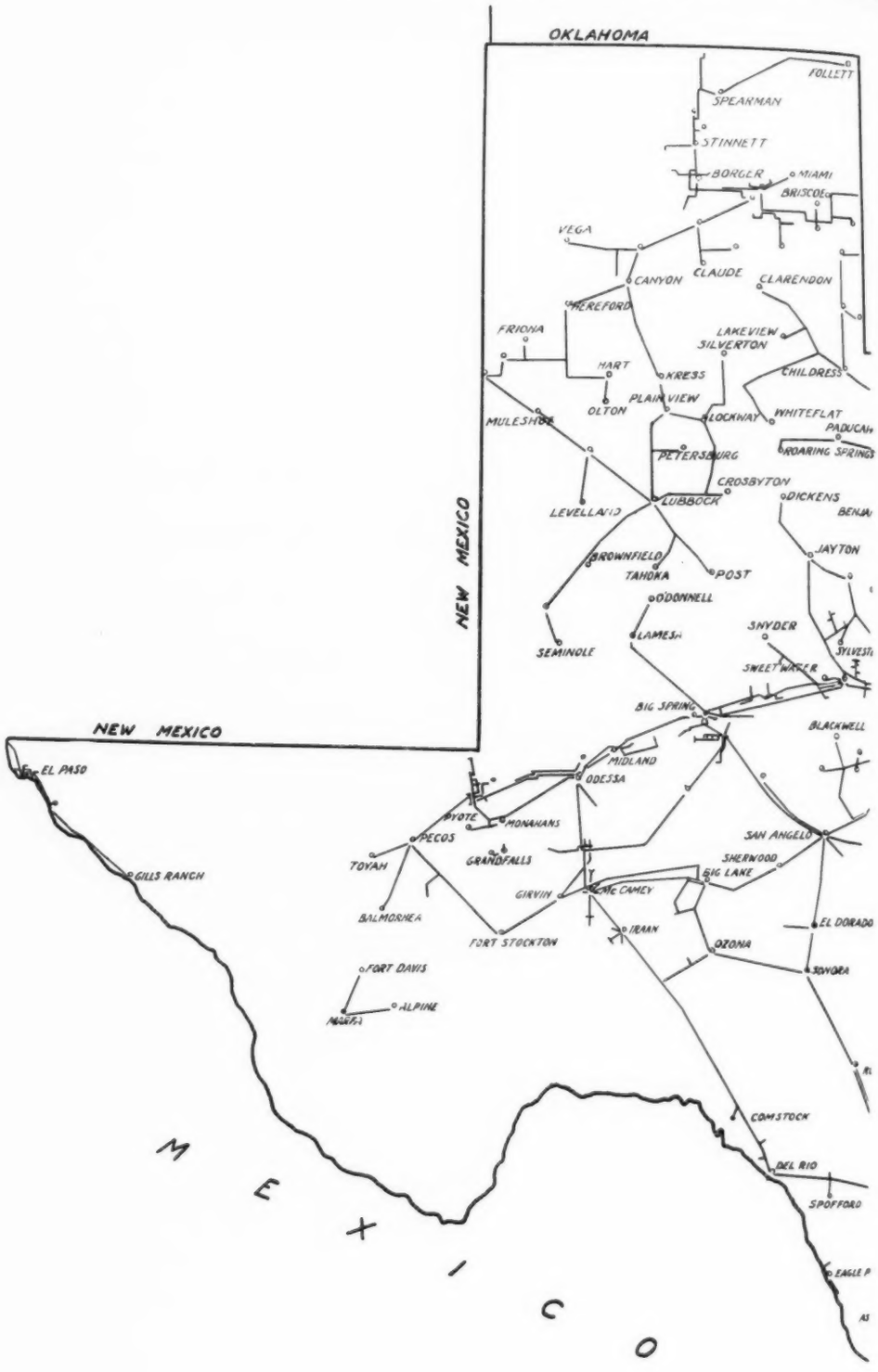
It is interesting to note that just before cementing, while circulating at the same rate as when the cement plugs were placed, the pump pressure while the lower batch of cement was being placed did not exceed 300 pounds. It is estimated that a pump pressure of at least 1,200 pounds would have been required had the Multiple-Stage cementing tool not been used.

Determination of the depth at which to place the cementing tool in the casing string was made by balancing the fluid columns inside and outside the casing so that the pump pressure would be a minimum.

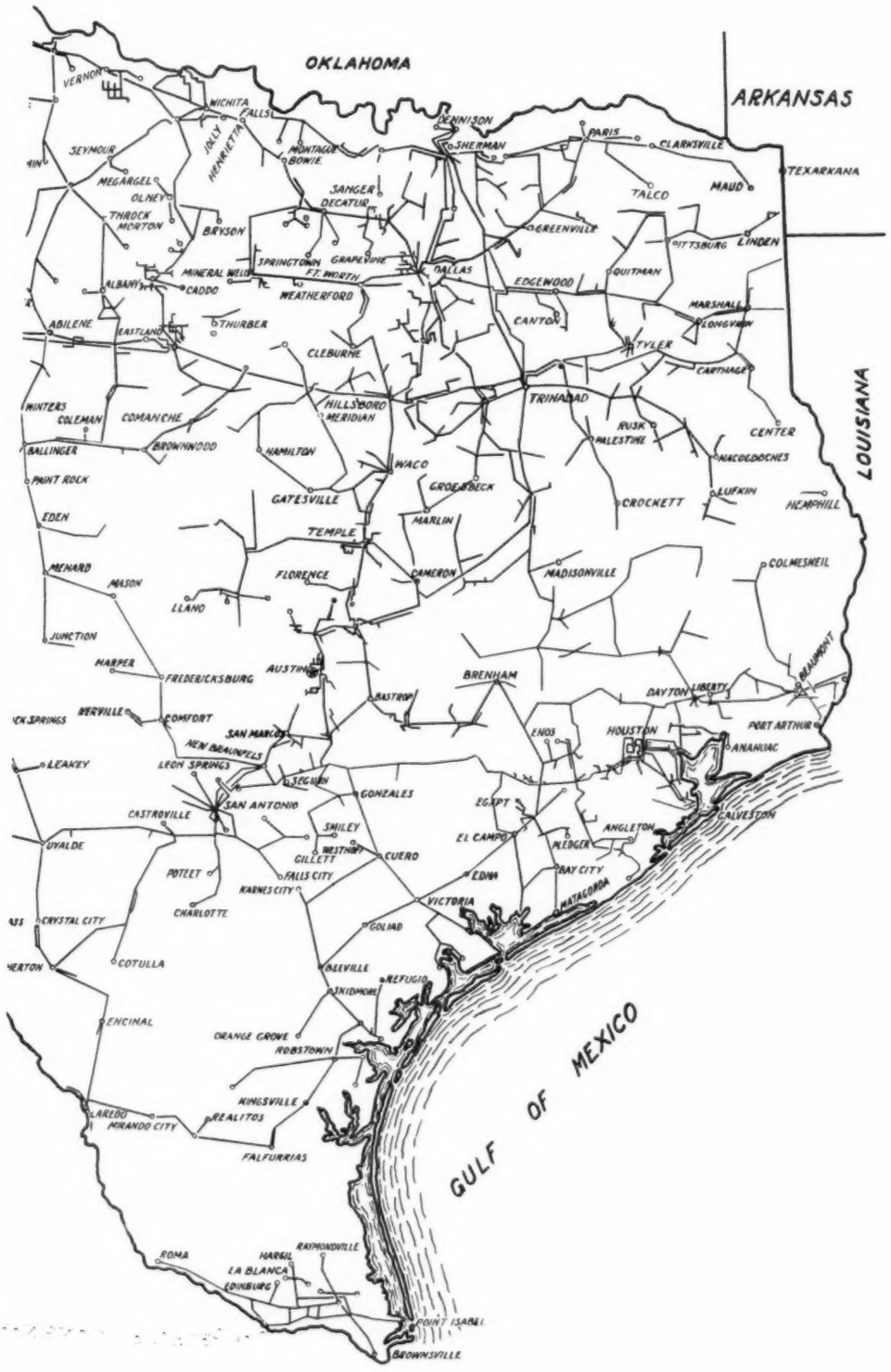
As the cementing tool opened the pump pressure dropped suddenly to zero. This was striking evidence of the positive action of the tool.

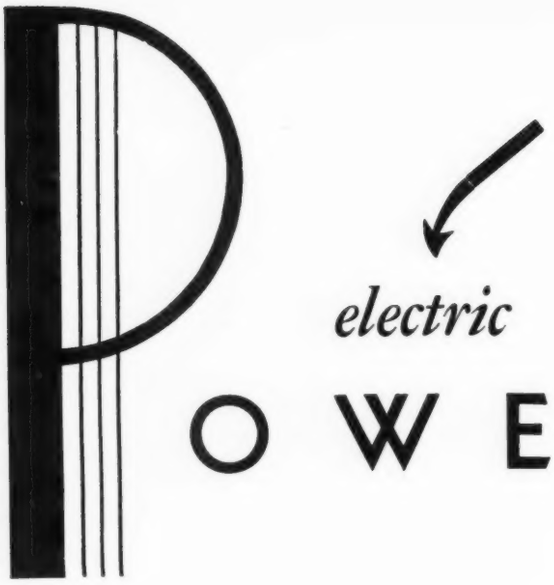
As soon as the cementing tool opens the lower batch of cement is in place and is not disturbed thereafter, thus facilitating its setting. In a deep well with a high bottom-hole temperature this is a highly advantageous feature. This process removes many of the hazards of cementing deep wells.

ELECTRIC POWER TRANS



MISSION LINES IN TEXAS





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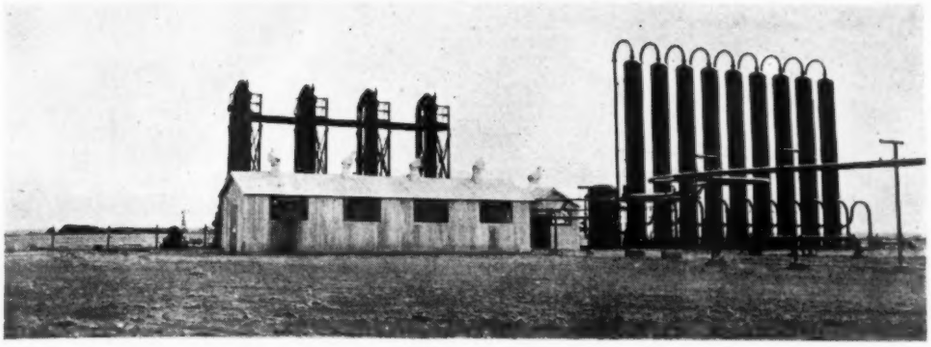
TRANSMISSION LINE electric service is the most desirable and dependable source of power available to the petroleum industry . . . from the time drilling operations begin until the refined product is sent forth to the consumer.

TRANSMISSION LINE electric power affords a dependable, ample flow of flexible power sufficient for every demand, with the desirable features of safety, automatic control, minimum of interruption hazards, convenience, simplicity of operation and low installation costs.

Texas Power & Light Company

***An inquiry will bring you one of our experienced engineers, without obligation, to go over your power problem at your convenience.**



A Texas Panhandle natural gasoline plant, showing refrigeration plant on left and absorbers on the right.

Natural Gasoline Plants in Texas

By F. R. STALEY

THE Texas Panhandle is the greatest producing district of natural gasoline in the world; about half of the production of the State is made in this area where most of its largest plants are located. Last year Texas produced 23.3 per cent of the country's total output, Oklahoma 24.8 per cent, and California 37.3 per cent. At the beginning of this year there were 128 natural gasoline plants in Texas,[1] having a combined capacity of nearly two and one-half million gallons daily.

Gasoline plants are located in most of the producing fields of the State. The absorption process is used in eighty-six plants, and the compression process in twenty-six of them; only one or two plants use the charcoal process. A combination of processes is used in the other plans. The total capacity of the absorption in Texas is approximately 1,900,000 gallons daily, and of the compression plants 232,000 gallons. Both low and high pressure absorption plants are operated.

The Phillips Petroleum Company, which is the largest producer of natural gasoline in the country, operates twenty-nine absorption type plants in Texas which have a combined capacity of nearly one million gallons daily. The Coltexo Corporation's plant at Lefors, having a capacity of 100,000 gallons daily, is the largest plant in the State. The largest natural gasoline plant in the United States is operated by the Shell Oil Company at Long Beach, Calif. Its capacity is 220,000 gallons per day.

The Fritch plant of the Natural Gas Pipe Line Company of America is one of the most recently completed plants in the Texas Panhandle. It is an example of a high pressure absorption type plant operated in connection with a natural gas transmission system. There are several plants of this type in the State. Many of the absorption plants, however, are designed for low pressure, and the residue gas is used in the field or sold to carbon-black plants, many of which are located in the Panhandle area.

The plant at Fritch was designed to treat 175,000,000 cubic feet of natural gas per day at a pressure of 610 pounds per square inch, with a lean oil flow of 560,000 gallons. The plant operating under these conditions produces 72,500 gallons of finished gasoline per day, grade 34-70 or a grade approximating 33 per cent butane.

The natural gas from the gathering system is first compressed to the pressure carried on the main line, and at this pressure passed through the absorbers. The stripped gas from the gasoline plant must be free from all water and hydrocarbon vapors that might condense and separate at line pressure or temperature before it enters the twenty-four-inch pipe line to Chicago. All condensable vapor is removed in a refrigeration process by which the gas temperature is lowered to 40 degrees F.

The equipment in the Fritch plant consists essentially of the following:

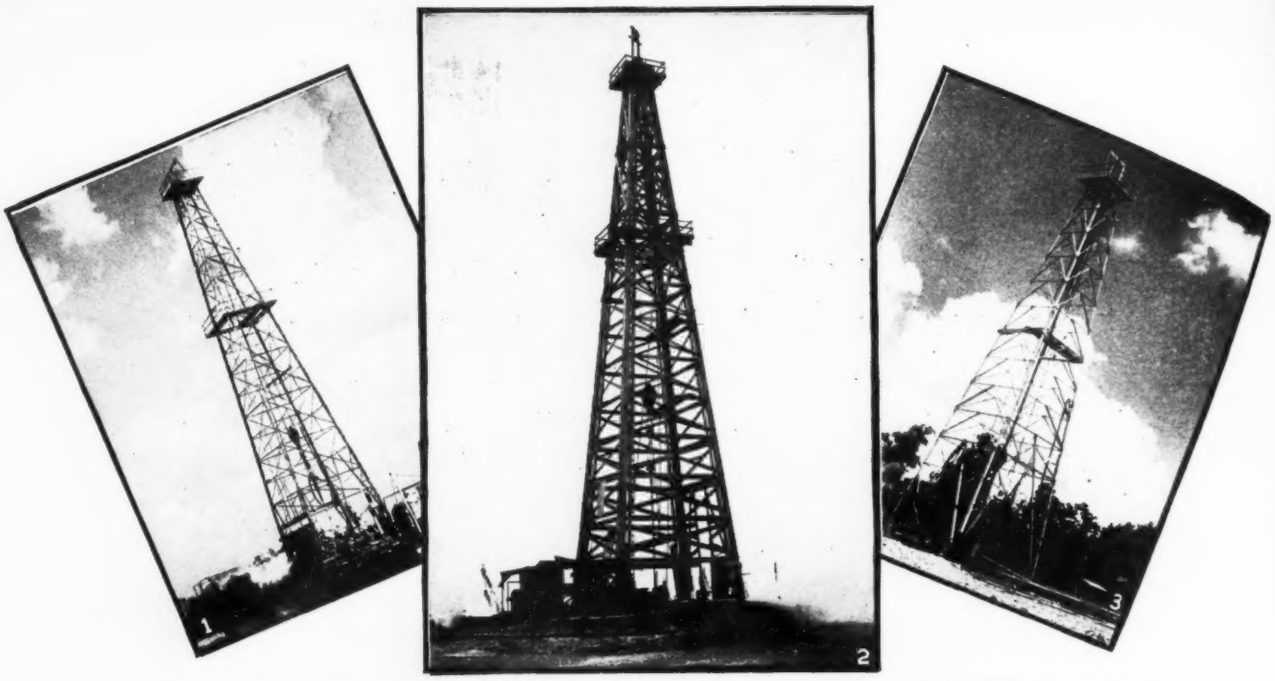
9 Absorbers, 4 ft. by 41 ft. 8 in. high.
1 High pressure fixed gas eliminator.
7 Heat exchangers, lean to rich oil.
1 Control preheater for high temperature fixed gas eliminator.
1 Rich oil preheater.
1 High temperature fixed gas eliminator.
1 Combined still and rectifier.
1 Preheater for the still.
1 Vapor fractionator.
1 Vapor fractionator reboiler.
6 Bentube sections for reflux condenser vapor fractionator.
1 Bentube section for vapor fractionator bottoms.
1 Accumulator for vapor fractionator.
8 Bentube sections for gasoline condensers.
12 Bentube sections for cooling lean oil.
1 Liquid fractionating tower.
6 Bentube sections for fractionator reflux.
1 Reboiler for liquid fractionator.
3 Gasoline heat exchangers.
1 Preheater for liquid to fractionator.
1 Bentube section for cooling gasoline.
1 Reflux accumulator.
40 Storage tanks 11 ft. by 40 ft.
6 200-horsepower single stage compressors.
2 500-horsepower B. & W. boilers.

Van Plant

The natural gasoline plant in the Van field is an example of a modern compression type plant. Because of the unit operation of this field only one plant has been erected. It is operated by the Pure Oil Company for the various producing companies. This plant produces about 40,000 gallons of stabilized gasoline daily from 15,000,000 cubic feet of natural gas.

It is a compression plant containing nineteen duplex gas engine driven compressors. The gas is compressed to 300 pounds in the second stage. A separate gas cooler and accumulator is installed for the low pressure stage of each unit, while

[1] U. S. Bureau of Mines, I. C. 6635.



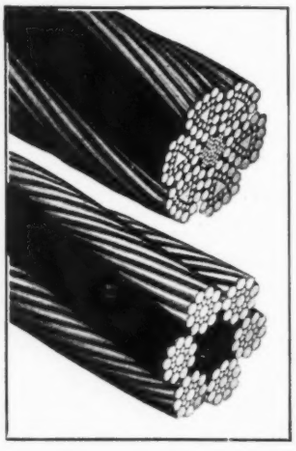
Some of the Important Jobs Done by Hercules (Red-Strand) Wire Lines in Texas

• *No. 1:* Rig of the Framar Oil & Gas Company that recently completed a well at Mykawa, Texas. Mr. F. R. Flanagan of this company reports that a 1″ Round Strand "HERCULES" Rotary Line on this rig drilled from 2,200 ft. to 4,500 ft.; made 96 round trips for coring, and set 4,820 ft. of 7″ casing. Mr. Flanagan also stated that this was the best line he ever used. • *No. 2:* One of the rigs in the Yount Lee Oil Company's new field at High Island, Texas. This well-known company has long been a user of "HERCULES" lines. • *No. 3:* Noble Drilling Company's rig near Kilgore. It is equipped with a 1⅛″ Patent Flattened Strand "HERCULES" (Red-Strand) Metallic Core Rotary Line. This line drilled one well at Oklahoma City, after which it was sent to East Texas where, so far, it has drilled twelve wells complete.

Money Is Being Saved by the Use of "Hercules" [Red Strand] Wire Lines

When you use a "HERCULES" (Red-Strand) Wire Line you are not experimenting with an untried product, for they have seen world-wide service, and their performance record has proved that they are safe, dependable and economical.

The exceptional ability of these Wire Lines to withstand wear and tear is not a matter of chance. They are made of acid open-hearth steel wire, and every wire used is first rigidly tested to make sure that it comes up to our exacting standards.



Construction is also an important factor. No one type of wire line is suitable for all Oil Field purposes, consequently "HERCULES" (Red-Strand) Wire Lines are furnished in a wide range of constructions in order to produce a line for every condition, and every line is made according to our exclusive methods of manufacture.

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1857 — SEVENTY-FIVE YEARS IN BUSINESS — 1932

only half the number serves the high pressure stages. Shell and tube type water coolers are used with alloyed tubes.

The raw gasoline is stabilized in a modern unit. The bubble tower is 4 ft. by 57 ft. and contains thirty trays. The stabilized gasoline shows a recovery of not less than 96 per cent. It is sweet and requires no chemical treatment.

All of the gas to the plant is measured by a master meter installed in a twenty-four-inch line at the plant. This meter is an orfice type recording. Automatic control instruments and devices are used throughout the plant for temperatures, pressures, levels, and rate of flow.

Electric power for the plant and the employees' houses is generated by two A. C. generators, each driven by a 190-horsepower gas engine. Two 200-horsepower fire tube boilers generate steam for the Van plant. Two redwood cooling towers are installed in the plant. One is used to cool the water from the gas coolers and the other to cool the water for the engine jackets. Motor-driven centrifugal pumps are used to circulate the water in the plant.

East Texas Plants

The Humble Oil & Refining Company built the first natural gasoline plants in the East Texas field for the purpose of conserving gas produced in the field. A plant at London, having a capacity of 10,000,000 cubic feet daily, started operating during October, 1931. The plant at Kilgore, having a capacity of 5,000,000 cubic feet, was started in November, 1931. Three-stage compression is used in each plant. The first stage is from 12.5 in. vacuum to 35 pounds discharge, the second to 300 pounds discharge, and the third to 1600 pounds per square inch discharge.

The third stage was installed for repressuring, but due to the demand for fuel gas all of the residue gas has been used in the field up to the present time.

The raw gasoline from the Kilgore plant is transported by pipe line to the London plant, where all of the raw gasoline is stabilized.

G. L. Kent[2] has pointed out that the operation of natural gasoline plants in the East Texas field has been very unsatisfactory since proration orders are based on production per well. Efforts to flow wells over a twenty-four-hour period having proven unsuccessful, the most efficient operation is intermittent flow. In order to keep from loading the lines, the Humble leases served by each line have been divided into three areas, one area on each line being flowed during the day shift. Pumpers endeavoring to finish their work during the eight-hour shift, flow the majority of their wells during the first few hours. This practice results in the lines being heavily loaded during the first few hours and very lightly loaded during the latter part of each shift. As the lines were designed to handle an evenly distributed load over a twenty-four-hour period, packing the lines for a short period each shift causes unbalanced load conditions at the plant. This is a very unsatisfactory method of operation, but it is the best that can be devised as long as proration is on the well basis.

The Humble plants at Kilgore average only two gallons of marketable gasoline per thousand cubic feet of gas as a result of the unfavorable operating conditions; it should be possible to obtain at least five gallons under satisfactory conditions.

The short periods of intermittent flow for each well allowed in the East Texas field is responsible for the following conditions: Intermittent plant load, low gasoline recovery, intermittent return of residue gas, which necessitates the purchase of fuel for drilling and lease operation, and finally higher lifting costs per barrel of oil.

The gas deficiency in East Texas has limited the number of gasoline plants erected, but there are at present about ten in operation, most of them being under 5,000,000 cubic feet capacity.

Stabilizing Equipment

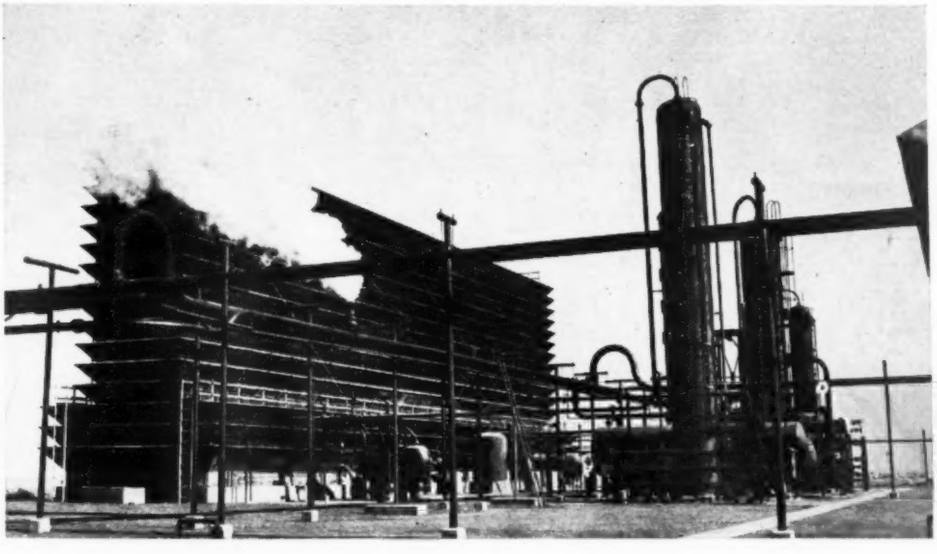
In recent years natural gasoline manufacturers have been able to produce more stable grades of natural gasoline, due to the development of highly efficient fractionating equipment and automatic control instruments. Refiners have been able to purchase the low vapor pressure grades of natural gas for blending motor fuels as a result of the adoption of natural gasoline specifications based on vapor pressure. A number of natural gasoline manufacturers market their stabilized grades directly as motor fuel.

The United States produced about 86 per cent of the world's total natural gasoline in 1931. The production in this country has steadily decreased the past three years, while the output of plants in foreign countries has consistently increased.

Liquefied Petroleum Gas

Liquefied petroleum gas is the by-product produced from the rectification of natural gasoline when manufacturing the low vapor pressure grades used in motor fuel. Commercial liquefied petroleum gases are composed of propane, the butanes, and small percentages of ethane or the pentanes, although efficient rectification makes it possible to obtain the various hydrocarbons of exceptional purity.

[2]Proceedings Eleventh Convention, N. G. A. A.



Cooling towers and distillation equipment at the Fritch, Texas, natural gasoline plant of the Natural Gas Pipeline Co. of America.

The Phillips Petroleum Company, the Skelly Oil Company, and the Lone Star Gas Company are the largest producers of liquefied petroleum gases in Texas.

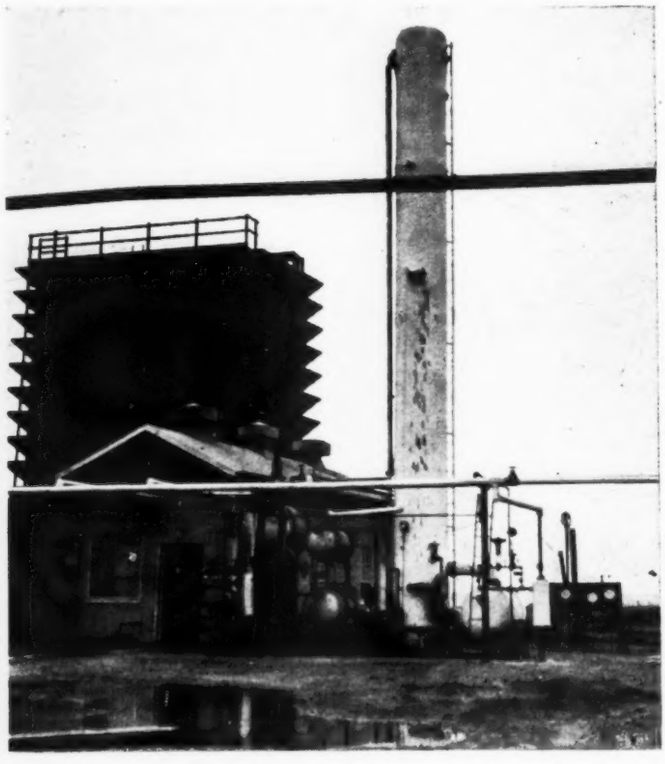
The principal uses for the gases are: For domestic fuel it is shipped in cylinders to homes that are not served with gas lines; for industrial heating operations where an economical, clean, and easily controlled fuel is required; for enriching manufactured gas of low thermal value; as a base material for manufactured gas, using air or flue gas as a diluent; as a solvent for various industrial operations; as a raw material for the manufacture of organic chemical compounds.

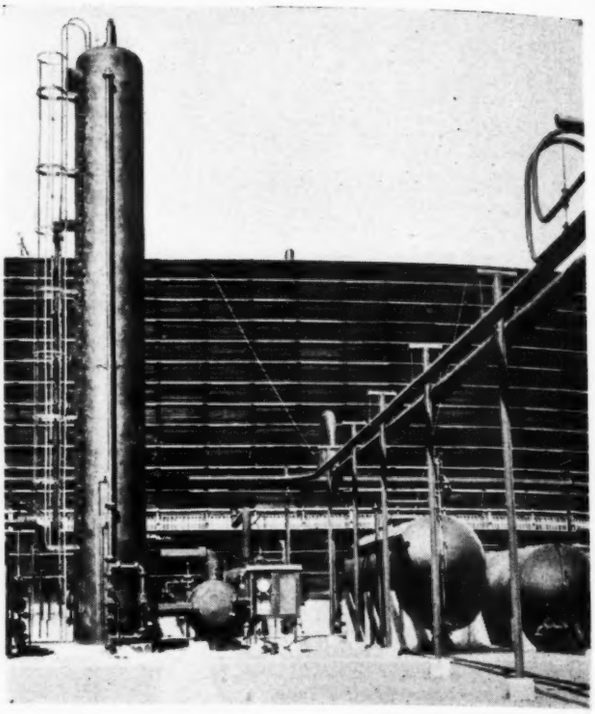
The manufacture of liquefied petroleum gases has been outlined by Kremser.* The raw gasoline is first processed in a primary rectifier from which a butane-free overhead is taken. The bottoms, containing a small percentage of propane, are separated in a secondary rectifying column into finished natural gasoline and an overhead cut consisting substantially of butanes.

The overhead from the primary column is condensed, passed to a water separator, and charged to the top of a weathering column, which serves to control the vapor pressure, rectification, and partial dehydration. These results are accomplished by introducing the cold feed to the top of a column which is operated at a constant pressure and thermostatically-controlled bottom temperature. No reflux is supplied, but a substantial degree of rectification is obtained due to the temperature differential between top and bottom of the column. The product leaving the column has a constant vapor pressure corresponding to the temperature and pressure existing at the bottom. This same type of design has been utilized as a substitute for rectification in small gasoline plants, for the removal of fixed gas from the crude and similar applications. The product from the weathering column is then passed through a chemical drier, followed by a filter, and finally to storage.

In a plant operated on this basis two primary products, one consisting substantially of butanes and the other almost pure propane, are obtained. From these products a variety of blends are made.

*A. P. I., June, 1932.





Stabilizer at the Fritch, Texas, natural gasoline plant of the Natural Gas Pipeline Company of America.

The marketed production of liquefied petroleum gases in the United States increased 58 per cent in 1931 over the previous year. The Department of Commerce shows the following figures for 1931:

Use	*Gallons*	*Per Cent*
Domestic - - - - - -	15,294,648	53.7
Gas Manufacturing - - -	6,184,655	21.7
Industrial and other uses -	7,023,516	24.6
Total - - - - - -	28,502,819	

Large Capacity Natural Gasoline Plants in Texas

Company	*Location*	*Daily Capacity Gallons*	*Type*
Coltexo Corporation	Lefors	100,000	Absorption
Phillips Petroleum Co.	Pampa	90,000	Absorption
Phillips Petroleum Co.	Pampa	75,000	Absorption
Phillips Petroleum Co.	Pampa	75,000	Absorption
Skelly Oil Comany	Borger	75,000	Combination
Nat. Gas Pipeline Co. of America	Fritch	75,000	Absorption
Signal Gasoline Co.	Best	70,000	Absorption
Phillips Petroleum Co.	Crane	70,000	Absorption
Phillips Petroleum Co.	Pampa	60,000	Absorption
Skelly Oil Company	Skellytown	58,000	Combination
Big Lake Oil Company	Texon	50,000	Absorption
Phillips Petroleum Co.	Borger	50,000	Absorption
Phillips Petroleum Co.	Borger	50,000	Absorption

3200 Pounds Pressure

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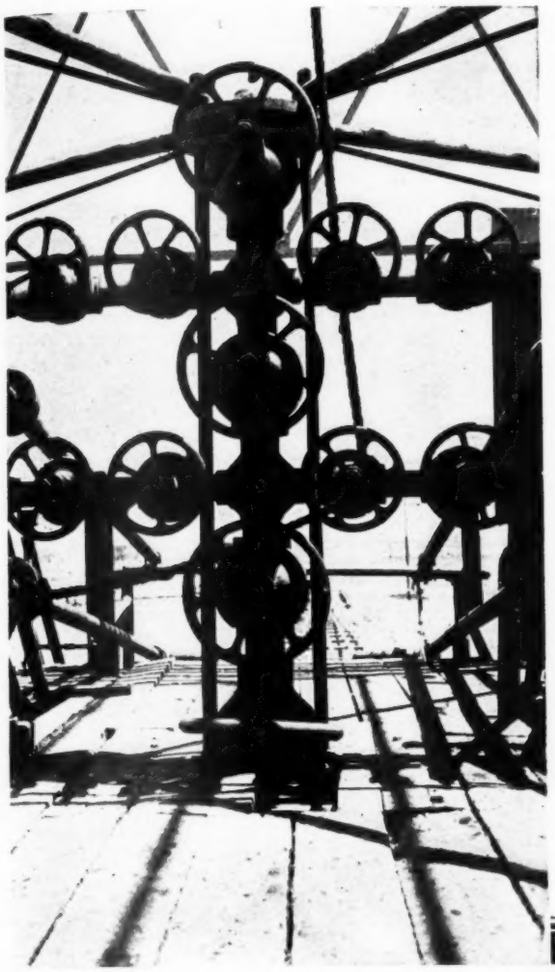

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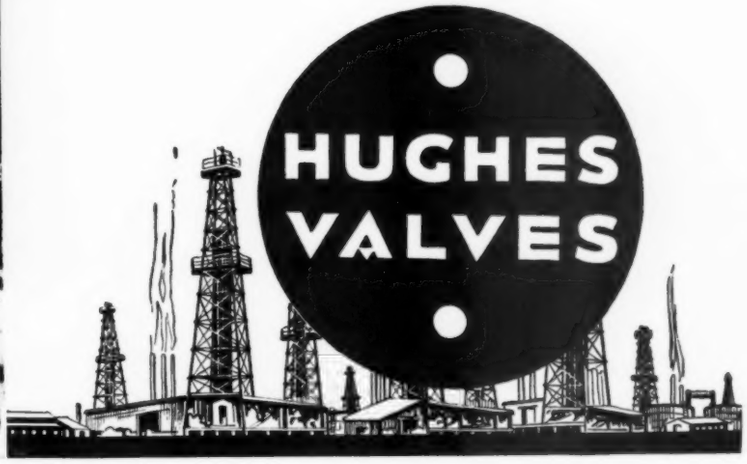

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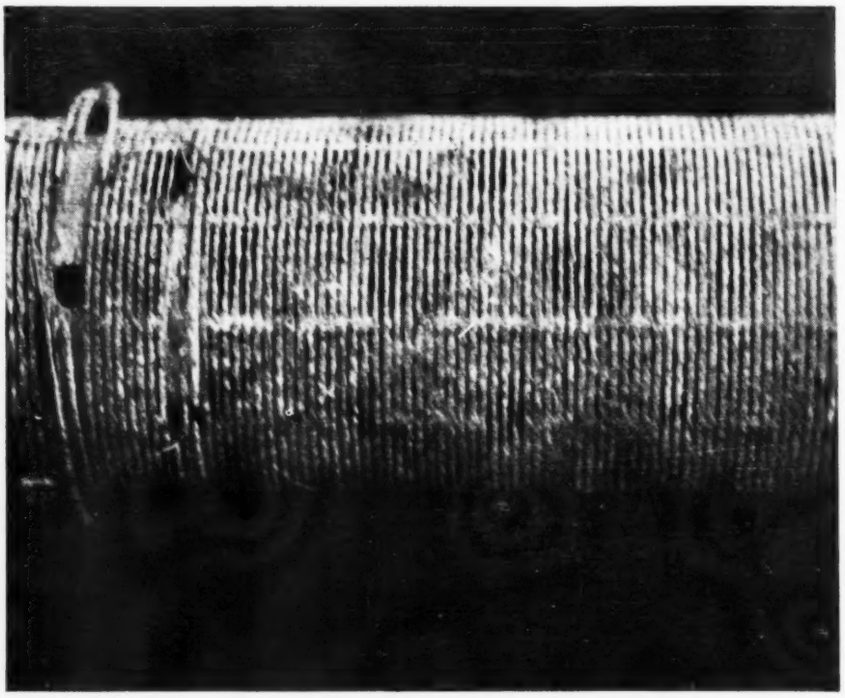
Corrosion Problems of the Texas Oil Industry

By STANLEY GILL☆

CORROSION of equipment is an important problem in all phases of the oil industry of Texas. This is, in part, due to the size of the Texas oil industry, but is even more truly attributable to special conditions prevailing in various parts of the State. These conditions are limited to certain fields, and to certain producing areas, and there are many oil fields in which equipment is not seriously corroded, many areas in which pipe lines are not rapidly attacked by soils and many types of crude oils which can be handled by refineries without serious corrosion troubles. On the other hand, corrosion troubles in localized sections are extremely severe, and a survey of the literature covering the corrosion problems of the oil industry shows that the oil fields in which equipment is most rapidly corroded are located in Texas; that pipe lines in the State are, in general, subject to more rapid deterioration than are those in most other sections of the country, and that the high sulphur crudes from West Texas are the cause of the most destructive corrosion which is experienced in refinery operations.



Corrosion of a screen wrapped with galvanized steel wire. This failure resulted in sanding-up of a well at Hull.

Corrosion of Production Equipment

Corrosion of production equipment is a serious problem in the fields of the Gulf Coast, in West Texas, in the Panhandle and in the group of fields in the Luling area. In other fields of the State, underground and surface equipment are subject to some corrosion, but in the sections mentioned the corrosion is so severe as to constitute a major problem of production operation. It should be pointed out that more or less corrosion is experienced in all oil-producing sections; that the deterioration of underground equipment is affected by corrosion, even when the effects of corrosion are not apparent from examination of materials removed from the wells. The most prevalent action of this type is the corrosion fatigue failure of sucker rods. Corrosion, so slight that it cannot be detected by examination of the rods, is a most important factor in the causation of mechanical breakage of sucker rods. Rods exposed to such corrosive attack are subject to breakage under mechanical loads only half as large as those which would cause failure in the absence of corrosion. The importance of corrosion fatigue has been discussed in previous papers. ([1] [2]) This action is found to be a contributing factor to the failure of sucker rods in almost every oil field, and is an example of the corrosion problems which are encountered even in areas where corrosion is not usually believed to exist. Problems of this class cannot be considered in a brief paper, and attention will be confined to the more obvious types of corrosion, which result in actual direct destruction of equipment.

Corrosion of production equipment is more prevalent in the Gulf Coast fields of Texas than in any other oil-producing area in the United States. ([1]) This is true, both because of the frequency of corrosion failures of casing, tubing and rods, and because the Gulf Coast fields are confronted with a unique corrosion problem of the most vital importance. This problem is the corrosion of the fine-mesh screens which must be used in all Gulf Coast fields. In the entire oil industry there is no corrosion problem which so seriously interferes with operation, or which adds as much to costs of production, as does corrosion of well screens in the oil fields of the Gulf Coast. This somewhat broad statement can be amply justified by actual records of Gulf Coast fields and wells. Detailed studies have shown that direct repair costs occasioned by corrosion of screens add, on an average, from two to three cents to the costs of producing a barrel of oil in the Gulf Coast. They show, further, that this direct cost is the smaller part of the total loss occasion by screen corrosion, and that a far greater expense results from loss of production, and loss of wells, as a result of the corrosion of screens. This corrosion is experienced in every field of the Gulf Coast area; there are numerous instances of wells in which from ten to fifteen successive settings of screens were made at a single producing depth.

The great expense entailed by corrosion of screen in the Gulf Coast fields has two causes: First, due to the fact that the mesh openings are only .007 inch to .012 inch in width, accumulation of corrosion products will seriously restrict flow of fluid into the well, and will result in rapid decline of production and excessive resistance to flow. In the second place, the character of the Gulf Coast sands is such that they will flow into a well, with the fluid, if the width of the screen openings is greatly increased. Corrosion of screens, therefore, results in admission of sand and in sanding up the wells.

☆Consulting Engineer, Houston, Texas.

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Far-sighted business men realize that permanent industries cannot be built on distress prices. They know that under healthy business conditions it is impossible to get or to buy something for nothing. When goods are cheapened to meet low quality* prices, both the seller and the buyer are harmed. When goods are sold below cost of production, the seller is immediately harmed and eventually the buyer is harmed because he will share in the loss to all business that such practice eventually brings about.

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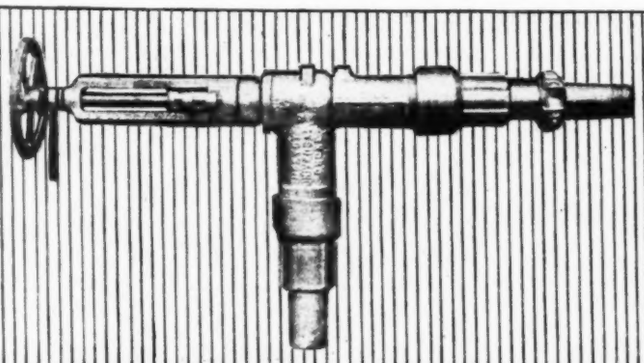
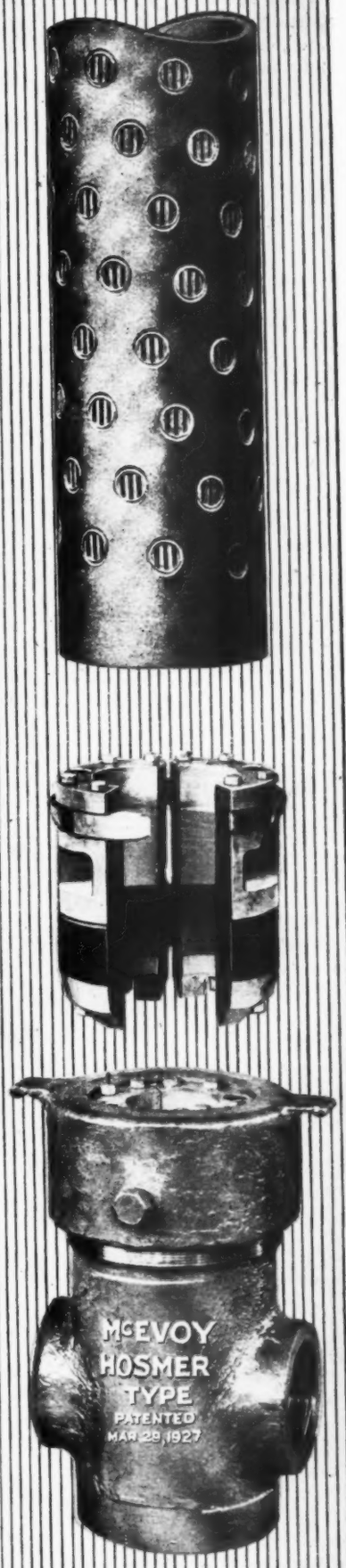
**Into goods of high quality goes the experience and integrity of the maker's personnel, policy and constant desire to make goods that give the user the most for the money, regardless of price.*

J. H. McEvoy
President.

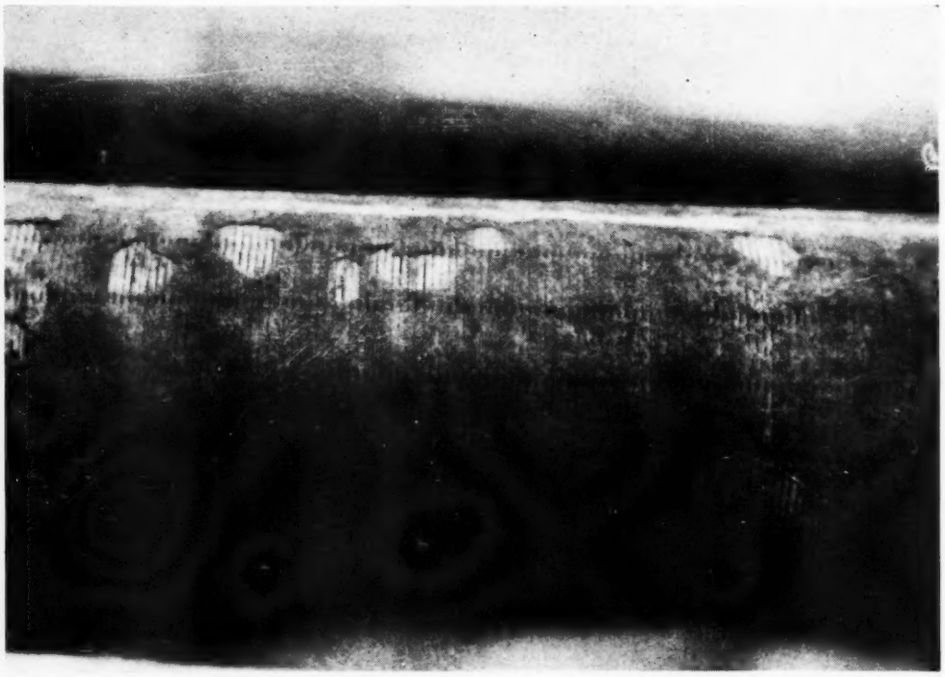




Corrosion of screens can be prevented by the use of proper corrosion-resistant alloys; but selection of alloys which will resist corrosive attack, and which can be satisfactorily fabricated, is extremely difficult. Much progress has been made along these lines, and marked increase in production of wells has resulted from the use of corrosion-resistant screens.

In many of the coastal fields, casing, tubing and rods are very rapidly corroded. This action is not confined to fields in which the waters contain hydrogen sulphide, but is also experienced in fields in which the waters are free of hydrogen sulphide. An outstanding example of severe corrosion by sulphide-free waters is found at Goose Creek, where ordinary tubing is punctured by corrosion in from one to three months in many wells. Corrosion of casing and liner is also rapid in many of the Gulf Coast fields, while corrosion of working barrels and balls and seats is experienced in practically every field in the area. The important bearing of corrosion of these parts on the life of tubing and rods is generally recognized, and has been discussed in a previous paper. ([2])

The short life and frequent breakage of sucker rods in the Gulf Coast area is also attributable, in a large measure, to the effects of corrosion. In some fields, such as Goose Creek, and the shallow cap rock wells at Spindletop and Humble, failure of rods occurs by direct pitting. In most of the coastal fields, however, actual pitting is far less important than is fatigue failure of rods, which results in excessive breakage even at relatively slight depths and under moderate pumping loads.



In sulphide fields of the Gulf Coast, corrosion products form upon the screen and prevent ingress of fluid.

Lease tanks corrode rapidly in the Gulf Coast area, both internally and externally. Wooden tanks are widely used, and many companies specify special painting programs for the exteriors of steel lease tanks used on the coast.

Even more serious corrosion of lease tanks takes place in hydrogen sulphide areas of West Texas, the Panhandle and Southwest Texas. In these areas, where the oil contains considerable quantities of free hydrogen sulphide, deterioration of lease tanks is extremely rapid. Tank roofs fail in from eighteen to twenty-four months, while corrosion of tank bottoms, accelerated by iron sulphide formed from the roofs, frequently results in puncture in less than six months. The lease tank corrosion problems in these fields is a particularly difficult one. The bottoms can be easily repaired and protected, but no simple method has been found economical for protecting the under-sides of the tank roofs. Much work has been done on this problem, and some success has attended the use of special grease coatings and of aluminum foil coatings. ([1]) Recent experiments with galvanized wrought iron sheets indicate that this material may prove highly satisfactory for the fabrication of roofs of lease tanks in the high-sulphide fields. Widespread corrosion of well equipment is also reported from the high-sulphide fields. Although actual corrosion puncture of tubing and casing has not, up to the present time, been severe in these fields, much difficulty from this cause is to be anticipated as the age of the fields increases. Up to the present time, the greatest corrosion expense in the high-sulphide areas has been caused by the embrittlement of sucker rods, balls and seats, and drilling lines. Vollmer & Wescott ([3]) have studied this embrittlement as related to wire ropes, and have recommended methods for its prevention. It is even more important in causing breakage of sucker rods and of balls and seats in the high-sulphide areas. Special alloys and reduction of the distance of ball travel have reduced ball and seat breakage. Wrought iron sucker rods have been quite successful in overcoming this condition, and a program of "rest periods" for sucker rod strings has also been found to reduce embrittlement failures.

In the fields of Central Texas, North Texas and West Central Texas well equipment is not subject to serious attack by corrosion. In isolated wells, some corrosion is experienced, and corrosion fatigue of rods is also a factor in rod breakage in all of these areas. No definite statement can be made as to future corrosion conditions in the East Texas field, but it now appears probable that no particular difficulty will be experienced with corrosion of tanks or well equipment in this area.

Corrosion of buried pipe lines causes a greater actual loss of material than does any other corrosion problem of the oil industry. Due to the great mileage of buried pipe lines in Texas and to the fact that soil corrosion conditions are, in general, fairly severe, the problem is of major importance to Texas pipe line operators. The worst corrosion is experienced along the Gulf, but soils in all sections of the State give rise to more or less rapid deterioration of buried pipe lines. The soil corrosion problem in Texas is in general similar to that in other parts of the country, and has been studied in great detail during recent years. Coating policies of the different pipe line operators of the State vary widely, but there is in Texas, as in all other sections of the country, an increasing tendency toward partial coating programs, controlled by corrosion surveys of the soils. Although many of the surveys which have been made have been highly inadequate in nature, the basic idea of this procedure is sound and economical.

A new and serious problem has arisen in the corrosion of the interiors of pipe lines handling West Texas crude. Previous experience with sulphide crudes fostered a belief that

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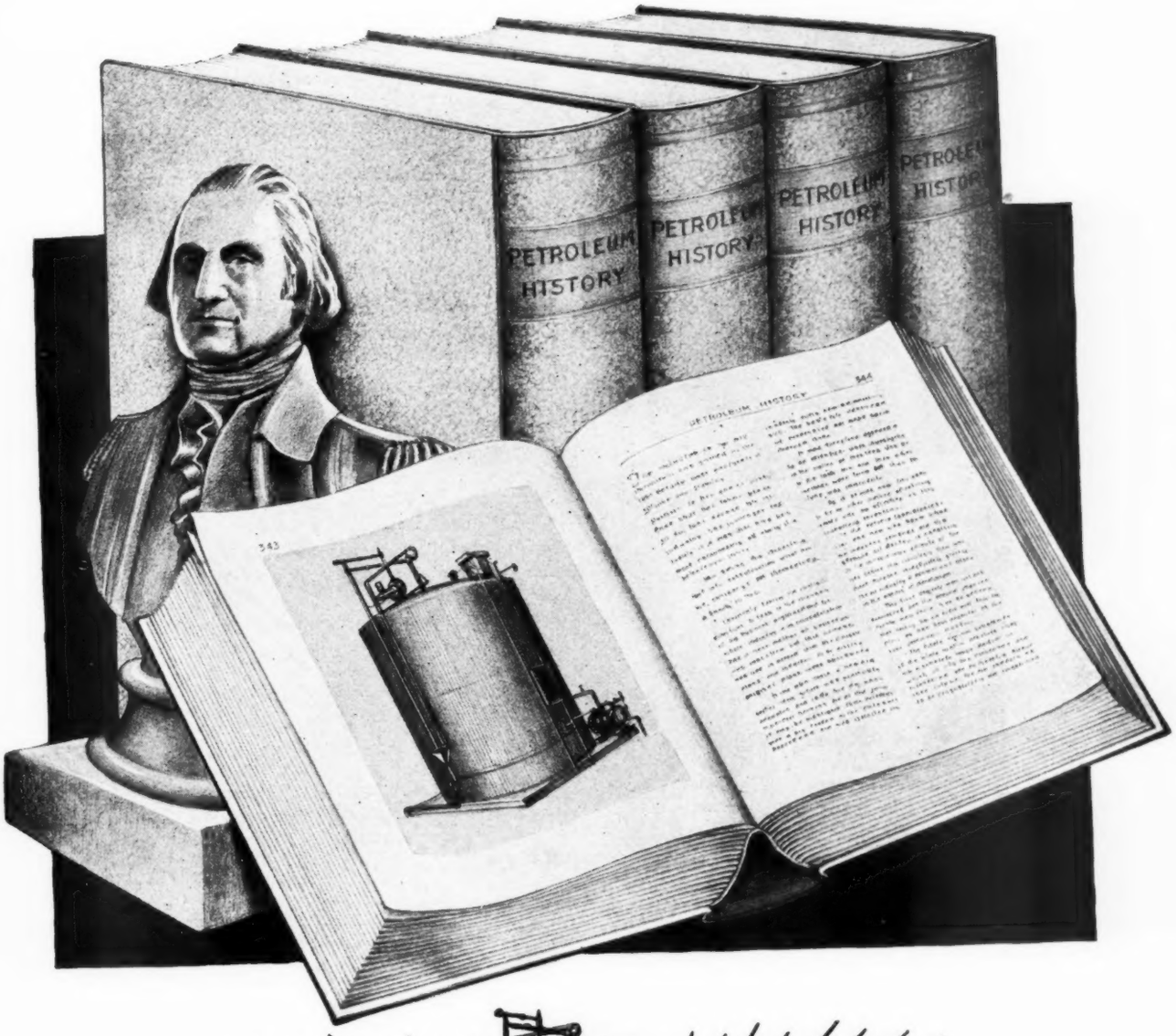

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West Texas oil would corrode the interiors of intermittently operated gathering lines, but would not seriously affect trunk lines. Experience has shown, however, that trunk lines handling West Texas oil are subject to very rapid internal corrosion; puncture of the pipe by pitting from the inside has taken place after less than four years' service of some of the trunk lines from West Texas. This is an exceedingly serious problem, both because it affects almost 100% of the pipe in the lines and because of the great difficulties involved in its solution. Several methods for the mitigation of this corrosion are being carefully studied and afford promise of success; it may be said with certainty, however, that any method finally adopted will necessarily add to the expense of pumping oil from West Texas.

Pipe line tanks used for the handling and storage of high-sulphide crudes are rapidly corroded. This corrosion is particularly severe on the under-side of tank roofs, where failures have occurred after service of less than two years. Exhaustive experiments have been made in an attempt to develop a satisfactory protective coating for the roofs, but have not been particularly successful. Wooden tank roofs are widely used and are quite satisfactory, although special methods must be used to avoid corrosion of nails and other metal parts and to prevent deterioration of the wood, which is seriously affected. Floating roofs are also used on working tanks handling West Texas crude. Breather-roof tanks have been successfully used for the storage of West Texas oil; they are completely filled with the oil to eliminate vapor space. Bottoms of tanks are also badly corroded, the action being accelerated by iron sulphide falling from the roof. Pipe line enamels have given very good results for the protection of these bottoms, as have concrete and special asphalt jobs.

Engines using high-sulphur oil as fuel are more or less seriously affected by corrosion; this is particularly apparent on valves and cylinder liners, which must be frequently replaced.

Corrosion of Refinery Equipment

Prior to the development of large production in West Texas and the Panhandle, corrosion problems in Texas refineries were not particularly different from those of other parts of the country. With crudes of low sulphur content, corrosion of refinery equipment is primarily due to the action of hydrochloric acid, which is formed from constituents of the water which is carried to the stills with the crude. Corrosion troubles arise also from the action of water used for cooling; this is particularly true of refineries located along the Gulf Coast, many of which must use more or less brackish water. Although serious deterioration of equipment results from these two classes of corrosion, methods of prevention are relatively simple and inexpensive. Thus, the effects of hydrochloric acid may be readily overcome by chemical neutralization; ammonia is particularly simple and inexpensive for the purpose, although caustic soda, lime and soda ash have also been used. Corrosion by cooling waters is combated by the use of Admiralty metal or other alloys, by chemical treatment of cooling waters, and by other relatively simple procedures.

With high-sulphur crudes, refinery corrosion problems are greatly increased, both in number and severity. Hence, the development of large production of sour oil in West Texas has resulted in accelerated depreciation of refinery equipment in every section of the country to which West Texas oil is transported for refining. The severity of the corrosion has been augmented by the concurrent tendency to higher temperatures and pressures for refining, since corrosion of cracking equipment is almost entirely due to the action of sulphur and sulphur compounds.([4 5 6]) The several classes of corrosion of refinery equipment, caused by the action of high-sulphur crudes, may be classified according to the nature of the corrosion reactions:

a. *Corrosion by hydrogen sulphide at atmospheric temperatures.* Particularly corrosion of tanks for the storage of high-sulphide crudes and distillates. This is entirely similar to corrosion of pipe line tanks.

b. *Corrosion in low-temperature distillation.* Affects heat exchangers, stills, bubble towers, condensers, run-down tanks and run-down lines of low-temperature fractionation equipment. The action takes place at parts of the equipment in which water is condensed and is primarily attributable to the action of hydrochloric acid formed by hydrolysis of calcium and magnesium chlorides, but is very greatly accelerated by the presence of hydrogen sulphide.

c. *Corrosion in high-temperature cracking and distillation.* Occurs at temperatures above 400° F., becoming particularly serious at temperatures above 700° F.([5 7]) The severity of the corrosion increases in direct proportion with increase of temperature,([5]) and is primarily attributable to the action of sulphur and sulphur compounds, increasing very rapidly with sulphur contents above 0.3%.([4 5 6 7]) It affects all parts of high temperature equipment, in almost direct proportion to their temperatures.

Methods for the reduction of the corrosion losses experienced in refineries handling high-sulphur crudes have been described in considerable detail by Samans.([7])

In general, corrosion of low-temperature distillation equipment is combated by chemical neutralization with ammonia, caustic soda, soda ash or lime,([6]) and by the use of special alloy equipment. Chemical neutralization is also employed in attempts to reduce high temperature corrosion, but with results less satisfactory than are obtained at lower temperatures. Special alloys are very extensively employed for the fabrication of equipment used for high-temperature cracking and distillation of high-sulphur crudes. Good results have been obtained, but there is still a need for improvement along these lines, since some troubles are experienced with even the best alloys which have been used for the purpose. Chromium plating, linings of cement and refractory and welded linings of sheets of corrosion-resistant alloys have been used for the reaction chambers of cracking stills, and have been fairly successful in some instances. Limitations of space prevent any detailed discussion of methods for prevention of corrosion of refinery equipment, and the discussions prepared by the American Petroleum Institute Committee on Corrosion of Refinery Equipment are recommended as the best source of information on this subject.

Summary

In the compass of a brief paper it is not possible to describe thoroughly either the numerous corrosion problems which are experienced by the oil industry of Texas nor the methods which are used for their prevention. The foregoing brief discussion serves merely to show the serious corrosion experienced by all branches of the oil industry, that much study is being devoted to its prevention, and that practically none of the problems has been finally or completely solved.

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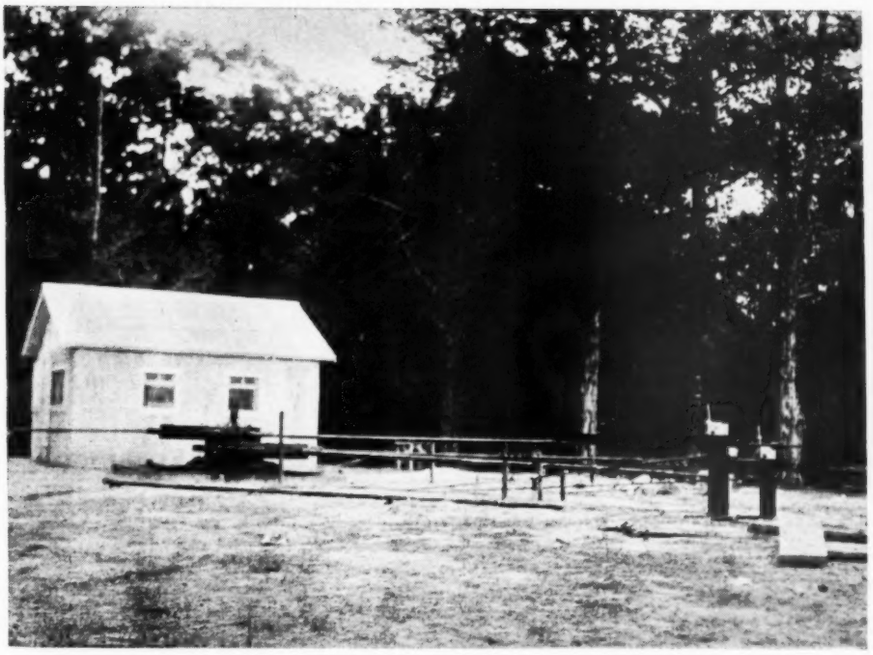
The East Texas Field

By K. C. SCLATER



Central power recently installed on Sun Oil Company's lease in Carlisle district, East Texas

SINCE its discovery two years ago more than 7,800 wells have been drilled and completed as producers and upward of 192,000,000 barrels of oil recovered in the East Texas field. Impressive as these figures are, it is quite likely that 4,000 more wells will be drilled and completed as producers before the field is totally developed and that the total ultimate oil recovery will be at least 1,250,000,000 barrels, or from six to seven times as much oil as has been produced to date. In areal extent, rate of development, number of wells drilled and the rate at which the oil has been recovered this field stands unequalled in the entire history of oil-field exploitation.

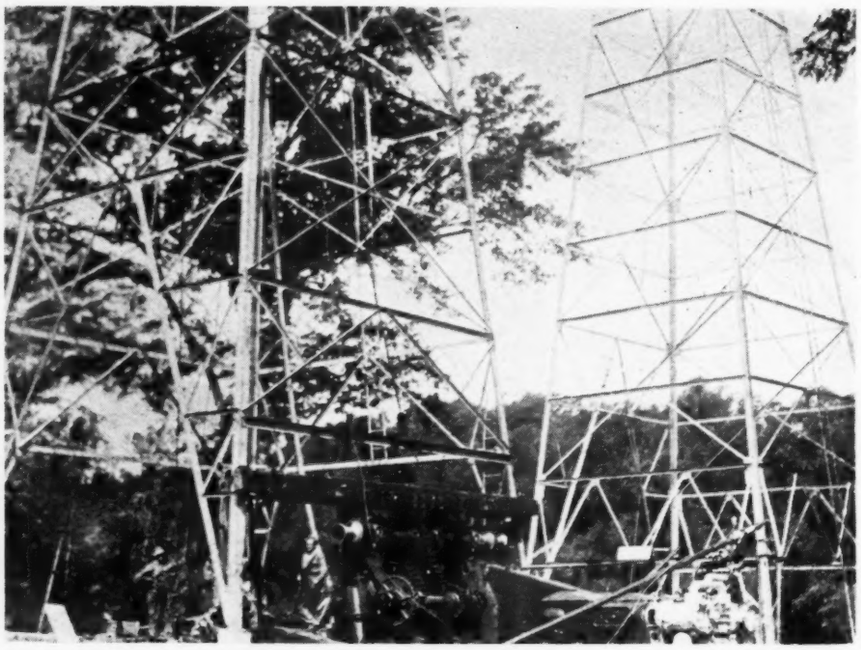
On September 8, 1930, the discovery well, the C. M. Joiner Daisy Bradford No. 3, seven miles northwest of the town of Henderson, in Rusk County, was completed at a total depth of 3,592 feet with an initial production of approximately 300 barrels a day. On December 28, 1930, E. W. Bateman's well, Lois Della Crim No. 1, ten miles north of the Joiner discovery well, was brought in for an estimated initial daily production of from 10,000 to 15,000 barrels from a total depth of 3,650 feet. On January 25, 1931, still another discovery, the Moncrief, Farrell and others' well, J. K. Lathrop No. 1, 14 miles northeast of the Bateman-Crim well and 7 miles east of the town of Gladewater in Gregg County, was completed at a depth of 3,574 feet with an initial production of 320 barrels an hour through a half-inch choke. On March 30, 1931, another well, Guy Lewis and others, Cook No. 1 in Smith County, was brought in 5 miles west of the Joiner discovery well, and flowed 137 barrels oil in 33 minutes through a ¾-inch choke. The depth to the top of the sand in this well was 3,672 feet. On May 5, 1931, a well was brought in four miles north and west of the Lathrop well for an initial production of 274 barrels in two hours through a 21/32-inch choke. This was the Mudge Oil Company and others' Richardson No. 1 in Upshur County. These five wells, each a discovery in itself, were brought in within the short period of seven months. Covering such a large area, they were a startling indication of the real extent of the field, and gave added impetus to an intensive drilling campaign that already was well under way. The proven productive area of the pool is 37 miles long and varies in width from 3 to 8 miles.

As the formations are easy to drill, wells were put down with remarkable speed. In the first six months of 1931 almost 1,100 wells were drilled and completed as producers. By the middle of August the daily production from the field was more than 800,000 barrels and was quickly soaring to 1,000,000 barrels a day when the field was put under martial law, which was declared August 15, 1931. All producing wells in the field were accordingly shut in August 17, 1931. From that date the production from the field has been restricted under orders issued by the Railroad Commission of Texas and the Military District Headquarters. The total production from the field has been held to a limited amount daily. Each well is allowed to produce daily a stipulated quantity of oil that is the same for every well in the field. As the number of wells increase, the allowable production per well is reduced in order that the total limit set for the field will not be exceeded. The complete schedule of changes of the allowable production per well issued under orders of the Railroad Commission of Texas and the Military District Headquarters since proration has been in effect in the field is as follows:

Aug. 17, 1931, to Sept. 5, 1931, field shut in.
Sept. 5, 1931, to Sept. 20, 1931, 225 bbls./well/day.
Sept. 21, 1931, to Oct. 12, 1931, 185 bbls./well/day.
Oct. 13, 1931, to Oct. 28, 1931, 165 bbls./well/day.
Oct. 29, 1931, to Nov. 6, 1931, 150 bbls./well/day.
Nov. 7, 1931, to Dec. 10, 1931, 125 bbls./well/day.
Dec. 11, 1931, to Feb. 4, 1932, 100 bbls./well/day.
Feb. 5, 1932, to March 15, 1932, 75 bbls./well/day.
March 16, 1932, to March 31, 1932, 72 bbls./well/day.
April 1, 1932, to April 15, 1932, 71 bbls./well/day.
April 16, 1932, to April 30, 1932, 67 bbls./well/day.
May 1, 1932, to May 15, 1932, 61 bbls./well/day.
May 16, 1932, to May 31, 1932, 59 bbls./well/day.
June 1, 1932, to June 15, 1932, 54 bbls./well/day.
June 16, 1932, to June 30, 1932, 51 bbls./well/day.
July 1, 1932, to July 15, 1932, 50 bbls./well/day.
July 16, 1932, to July 31, 1932, 46 bbls./well/day.
Aug. 1, 1932, to Aug. 15, 1932, 44 bbls./well/day.
Aug. 16, 1932, to Aug. 31, 1932, 43 bbls./well/day.
Sept. 1, 1932, to Sept. 15, 1932, 50 bbls./well/day.

Up to August 31, 1932, the allowable production per well was based on a limit of 325,000 barrels per day for the entire field. On September 1, 1932, the limit for the field was inincreased from 325,000 to 375,000 barrels per day, and explains the increase in the allowable production per well to 50 barrels per day for the first 15 days of September, 1932.

From December 21, 1931, to February 15, 1932, a num-



Offsetting wells in Sabine River bed area. They are only 42 feet apart.

ber of companies in the field of their own volition shut down their wells on Sunday in an effort to maintain the allowable production per well within the field limit over a longer period.

Proration, although it has had little effect on slowing up drilling operations in the field, has had a profound influence on production practice.

Before proration was put into effect a year ago, certain areas in the field had suffered an abnormal decline in rock pressure as a result of flowing wells being produced without any pressure control. This fact was brought forcibly to the attention of producers when bottom-hole pressure readings showed positively a marked readjustment of underground pressures. Prior to the enforced shut-down of the field by martial law, August 17, 1931, a number of wells had to be put on the pump and others showed signs of nearing the end of their flowing life. Anticipating that these wells would soon have to be pumped, complete surface equipment for pumping was installed at a number of wells. Since proration has been in effect the rock pressure in these greatly depleted areas has been building up rapidly until today it is from 100 to 300 pounds higher than it was a year ago before the field was prorated, and many of the wells equipped a year ago for pumping are still flowing. After this experience and the uncertainty that has always attended proration in this field producers now are prone to give more weighty consideration than ever before to the problem of when their wells shall reach the pumping stage, and the most suitable equipment to use when that time comes.

According to the records of the Railroad Commission, on September 1, 1932, there were 151 pumping wells and 14 "dead" wells in the field. Water is known to be present in at least 142 wells and the total quantity of water produced is estimated to be somewhere in the range between 2,500 and 3,700 barrels. The Overton area in Rusk County has the largest number of water wells and the west side of the field between Overton and the Sabine River has the most water wells of any part of the field. On the first day of June, July and August, there were 145, 148 and 148 pumping wells and 12, 14 and 14 "dead" wells respectively. It is noted that the "dead" wells change quite often in respect to the wells affected, but that the total number is fairly consistent. In addition to the 151 wells that now are being pumped, there are, at this writing, about 200 more equipped for pumping.

More than 650 companies or individuals have been operating in the field. Naturally the need arose for drilling regulations with regard to limiting the penetration of the pay sand because of water. The original depths to the water table varied over the field from 3,307 feet to 3,342 feet sub-sea datum, and a sub-sea depth of 3,320 feet was taken as the water table for the field. Regulations were issued with the proration orders September 5, 1931, limiting penetration to two-thirds of the distance from the top of the sand to the known water table, and requiring all wells that had been drilled into water to be plugged back to ten feet above the water table.

A Railroad Commission order of September 2, 1931, requires that all wells be equipped with a string of tubing, of not greater than 2½-inch diameter, and that the lower end be not higher than the top of the producing oil sand. Also the gas-oil ratio must not exceed 700 cubic feet per barrel.

As a result of the restrictions and regulations that have been applied, production methods of the most advanced type are being rapidly adopted by all producers in the field.

Foundation and cellar under construction on Sabine River bed well on the Travis-Radditz State Lease.

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Bottom-hole pressures are being taken systematically in a number of key wells in the field and a close check kept thereby on the decline in rock pressure of the field as a whole. This information is of a most vital nature in predicting the changes in underground conditions, and their effect on future producing operations.

From rate-of-flow tests at different bottom-hole pressures in wells it is known from the pressure-drop and other characteristics that large variations in the permeability of the producing sand exist. Tight sand areas, that is, where the sand is not very permeable, can, by careful observations on flowing wells, be plotted on a map. Likewise, loose sand areas where the sand is quite permeable can be outlined. A "tight" sand may have as great an oil content as a "loose" sand, but the possible rate of recovery will not be so great as that of a "loose" sand. Under the low rates of flow that prevail in East Texas a "tight" sand is not a handicap. So far as water encroachment is concerned, a "tight" sand is less susceptible to this menace than a "loose" sand, hence the probability of wells in "tight" sand areas making much water will be remote. This may mean much lower lifting costs in the later life of the wells in the "tight" sand areas and possibly much higher ultimate recovery than in the "loose" sand areas.

To date the rock pressure has declined to 1,400 pounds, the present average rock pressure for the pool. Assuming an original rock pressure of 1,600 pounds, this is a total decline of 200 pounds. The total oil produced from the pool is 192,000,000 barrels or 960,000 barrels per pound drop in pressure. Assuming that at least 200,000,000 barrels of oil has been produced—and this is probably nearer the actual quantity—instead of only 192,000,000 barrels, the recovery per pound drop in rock pressure is 1,000,000 barrels.

Water encroachment and water drive in the East Texas field have been the subject of much discussion. Based on the fact that the rock pressure is declining at the present relatively low rate of withdrawal of 325,000 barrels daily, it is assumed that the oil is being withdrawn from the pool at a rate too great for the water to follow up the oil. Such an assumption is not altogether warranted.

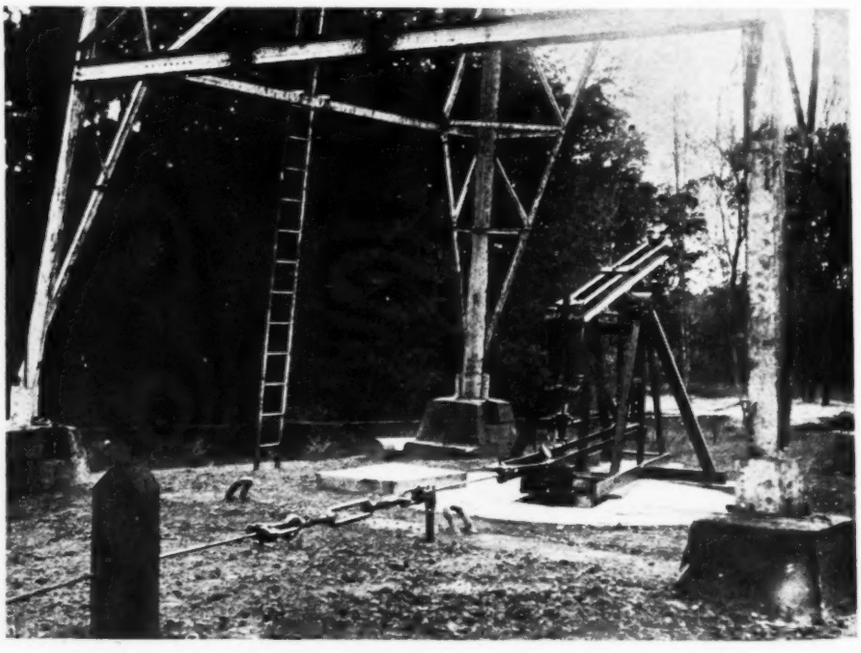
As various constituents of natural gas are in solution in the oil in the reservoir in both the gaseous and the liquid phase, the oil in this state is not an incompressible fluid. Indeed, it may be highly compressible, depending on the quantity and character of the gaseous constituents dissolved or in solution in the oil. As the oil and its dissolved gas are produced, a reduced pressure area is created in the sand around the well. The gas-oil fluid remaining in the sand being compressible will expand, hence the volumetric space occupied by a unit of the gas-oil fluid remaining in the sand will tend to increase. What the magnitude of this increase is depends, of course, on the character of the oil and the quantity and character of the various gaseous constituents in solution. Analyses of East Texas crude oil and its volatile constituents indicate that the change of volume may be considerable. In considering water encroachment and a water-drive in the pool the effect of this volumetric change of the gas-oil fluid remaining in the reservoir cannot be ignored. The rate of travel of the water-oil contact toward the well would be considerably less than is generally assumed. Stated in another way, it should not be assumed that the space occupied by a million barrels of oil at the surface is the same as that occupied in the reservoir.

There is also the permeability of the sand to be considered. This will change the pressure gradient in the sand between the water-oil contact and the well while oil and gas are being withdrawn. Permeability is the greatest underground factor influencing the rate of water encroachment. Already there is evidence in the field that a greater degree of water encroachment may be expected in wells in certain areas in the central west portion underlain by water than in wells farther to the west. Also it is found that the highest bottom-hole pressures are not always found in wells on the extreme west edge of the field. These anomalies are the result of the combined influence of underground factors about which at present little is known. Until more is known of these factors and a better understanding of their influence is obtained, predictions regarding the length of flowing life of wells in the western part of the field underlain by water can have no practical value; besides, they may be highly misleading.

Wells on the east edge of the field, even under the present restricted rate of production, will derive no great benefit from a natural water-drive. The expulsive medium forcing the oil into the hole is gas energy. As the field grows older the pressure gradient in the pool from west to east will be downward and will become more pronounced, assuming, of course, no repressuring program for the field. In many wells on the extreme east edge of the field the flow is beginning to weaken perceptibly, on account of depletion of gas energy. The sand is so thin that there is no great supply of energy upon which the wells can draw. There are several small areas where the rock pressure has declined to 500 pounds and free gas is present in the sand.

It is expected that the number of wells on the east edge of the field that will have to be produced by pumping will be greatly increased within the next six months. About 200 wells in the field are being produced through tapered tubing. At small rates of flow paraffin deposits in the tapered tubing, hence flowing the wells intermittently has been resorted to in order to flow the well at higher rates of flow. Tapered tubing for flowing wells in East Texas would seem, therefore, to have a very limited use.

The East Texas field will be a veritable proving ground for flowing and pumping equipment for several years to come.



Jack pumping well on Sun Oil Company's lease in the Carlisle district, in south end of field. Note the trim concrete base, raised block for sucker rods and hold-down links for portable pulling machine

The Use of Tubing Flow Packers in East Texas

MANY producers in the East Texas field are not overlooking the fact when placing wells on production that the more gas-energy conserved in the sand around their wells the greater will be the ultimate quantity of oil recovered. Any device designed for the express purpose of conserving gas energy and to assist the producing capabilities of the well is of especial interest to producers in East Texas at this early period in the life of that field.

One such device is the American Flow Packer, which has been in successful use in other fields for several years. This packer is now in use in a large number of wells in the East Texas field. Some have been in continuous use in wells without having been pulled since May, 1931, and apparently are giving satisfactory results.

An important feature of this packer is that it can be used as a flow-packer for a well producing through the tubing by natural flow or by gas-lift, also as a packer in a pumping well. In the East Texas field also it is found to have an advantageous application in the "washing-in" of wells.

It is made in regular sizes to run on 2-inch, 2½-inch, or 3-inch tubing, plain or upset, in any size casing from 5 3/16-inch to 8¼-inch diameter.

The upper part of the packer has a ball and seat check valve opening upward into the tubing. The under side of this valve communicates with the annular space between the tubing and casing through a set of ports machined in the wall of the packer. Another set of ports, machined in the wall of the lower end of the packer, communicates with a set of valves that project into a chamber inside the tubing. These valves are designed so as to impart to the fluid as it enters the chamber a swirling motion that is said to aid in inducing an upward flow in the tubing. A mud anchor that extends to within a few feet of the bottom of the hole is attached to the bottom of the packer and is of the same diameter as the tubing in the well. The packing rubber is an inverted cup of ample length and sturdy design to withstand the most severe service.

When the packer is run in the hole the upper ball and seat valve is held closed by means of a disk, thus by-passing the oil to the annular space in the casing and facilitating the lowering of the tubing at the desired speed. Only after the packer is at the desired depth and it is certain no adjustment of the tubing will be necessary before being put into operation, the disk is broken by dropping bolt or rod, requiring no mechanical operation of the tubing.

In certain areas on the east edge of the field where the rock pressure is low or wells show signs of weakening in flow, it is customary with some operators in completing their wells to run a flow packer on the bottom of the tubing, the object being to prolong the flowing life by conserving the gas energy. It has been found that the use of a flow packer is advantageous in "washing-in" wells. The packer is set as low in the casing and as close to the top of the sand as the perforated liner in the well will permit. It is the practice to set the upper set of perforations, which usually consist of 24 holes of ¼-inch diameter, three or four feet above the top of the producing sand, and the lower set of perforation as close as possible to the bottom of the hole. Connections at the casing head are arranged with a 3-inch bypass between the casing and the tubing. Water is circulated down the casing then up and on out through the tubing into the slush pit to wash the mud from the hole. Water is circulated until the return shows no mud. Usually this takes from 150 to 200 barrels of water. Oil is then pumped down the casing and up through the tubing to start the flow. Usually, if available, live oil is taken direct from nearby producing wells for this purpose. The pressure required to wash in a well in this manner with a flow packer will vary in different wells from 375 to 425 pounds. When no packer is used and the well is washed in with open tubing the pressure required to start flow will be much lighter than this.

With a flow packer on the tubing, the pressure, after starting to pump the oil, will rise gradually to the maximum of 375 or 425 pounds, then after the live oil has entered the tubing through the flow packer the pressure drops back gradualy to about 200 pounds, when the well starts to flow unassisted and the oil pump is shut down. The flow is usually lively but is quite steady and free from violent surges such as are usually present when a well is brought in.

As the packer aids in inducing flow, it is claimed to be more effective than open tubing in washing any mud fluid or cutting from the bottom of the hole when the well starts flowing. This, together with the fact that a smaller pressure is required to wash in the well when a flow packer is used reduces the hazards of mudding the face of the sand

Top: View of flow packer showing position of upper and lower ports. Bottom: Temporary well hook-up for washing-in wells with flow packer in East Texas.

such as is present when a high pressure is used to wash in the well.

Washing in wells in this manner is a remarkable advance over the swabbing methods so often unnecessarily used in the earlier development of the field.

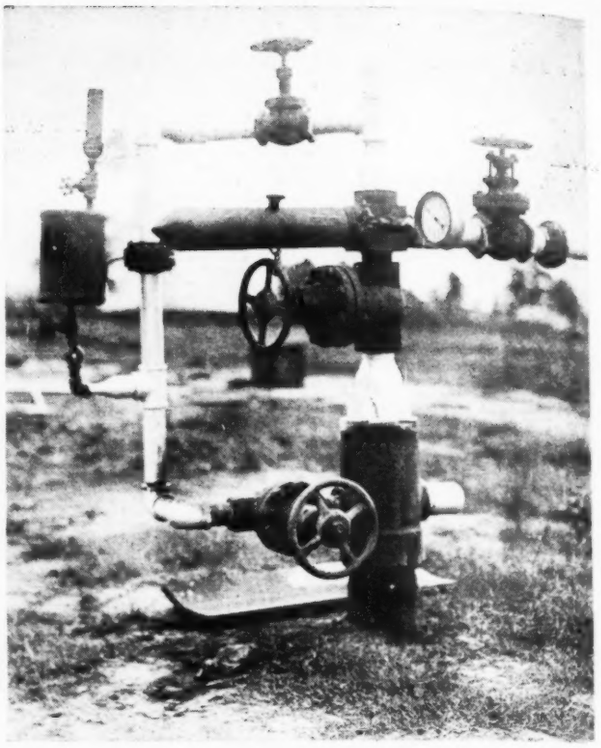
By putting in a flow packer when the well is completed, the pulling of the tubing at a later date and disturbing the well to install a packer when the flow weakens, will not be necessary. As the pressure builds up below the packer rubber, the cup expands and makes a secure seal, thus keeping the pressure conditions steady in the bottom of the well and insuring the efficient use of the gas-energy in lifting the oil.

If the well is believed to be near the pumping stage a common working barrel can be run on top of the packer and the standing valve removed, then when the well stops flowing the standing valve with gas anchor can be inserted, the sucker rods run, and the well put on the pump without disturbing the tubing.

Important advantages in using the flow packer are that it aids materially in flowing weak wells; additional gas to flow the well can be supplied down inside the casing; however, this advantage is rendered invalid due to regulations prohibiting the use of the gas-lift in East Texas. It is possible by using the flow packer to circulate at higher pressure without damage to the face of the producing sand.

While running the tubing the flow packer is an effective safeguard. In a well in East Texas a string of 3,000 feet of tubing that dropped 800 feet in a well suffered no serious damage because the flow packer on the bottom greatly retarded the rate of drop. The hazard of "corkscrewing" of the tubing is virtually eliminated when a flow packer is run.

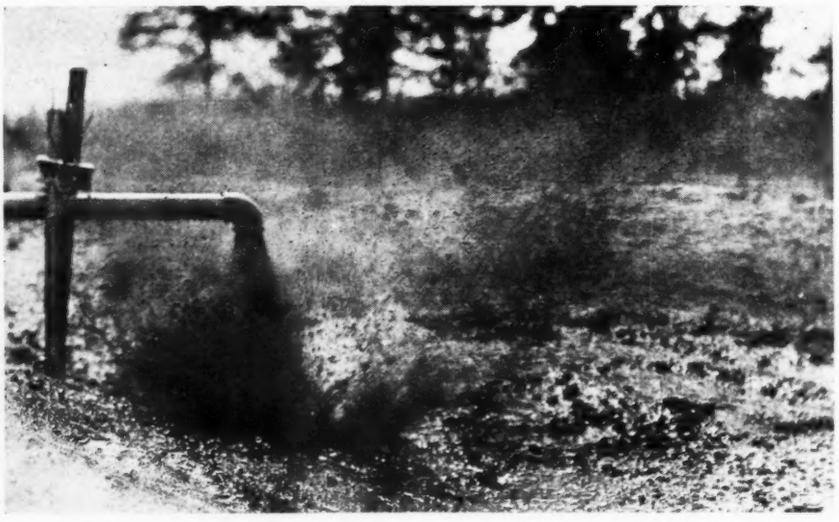
There are several flowing wells in the Kilgore area equipped with flow packers. They were installed fifteen months ago. Paraffin troubles are prevalent in these wells, nevertheless, the flow packers have been undisturbed. Every few months the wells are treated with chemicals to remove the paraffin. The chemical is placed in the well through a lubricator on the casinghead bypass connection between the casing and tubing. About 50 barrels of oil is bypassed from the tubing into the casing with the chemical from the lubricator. After closing the by-pass connection the well is opened again into the flow line and the deposit of paraffin flowed out with the oil. This has proved very effective in these wells.



Flowing well equipped with flow packer. Note lubricator for chemical for removal of paraffin.

It is obvious from the construction of the packer that there is no difficulty when the tubing has to be pulled. As the packer is held securely against the walls of the casing by the well pressure from below it is instantly released when the tubing is pulled upward.

The fact that more than 400 wells in East Texas are equipped with this flow packer is evidence of its merit.



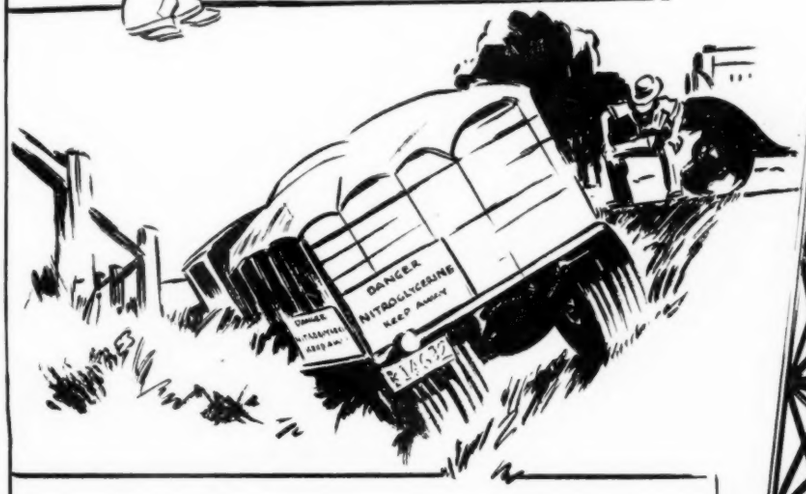
Type of flow established in East Texas well when washed in with flow packer.

STRANGE.... *but* TRUE

HAPPENINGS IN THE PETROLEUM INDUSTRY

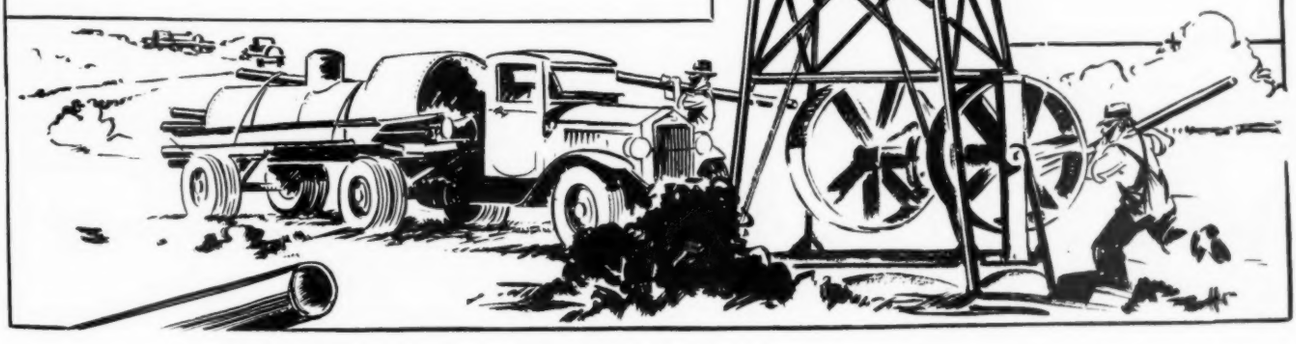
A boiler fireman standing directly in front of a boiler was uninjured in an explosion that completely destroyed the boiler house in an Arkansas refinery.

A Yale University professor has found that a mixture of four-fifths air and one-fifth pure methane gas will stimulate tree growth, often causing them to bud four to six weeks ahead of trees not subjected to the mixture.



An Oklahoma truck driver has run into a ditch and upset a load of nitroglycerin on two different occasions without having an explosion.

J. A. Wally, Millvale, Pa., contractor, upon returning to the site of a well he was drilling, found that thieves had stolen all his equipment except the derrick and a bull wheel. The engine, boiler, ropes, casing and all tools were taken, including the tools that were in the well.



NATIONAL PUMPING UNIT

TYPE SW-130

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V-belt drive

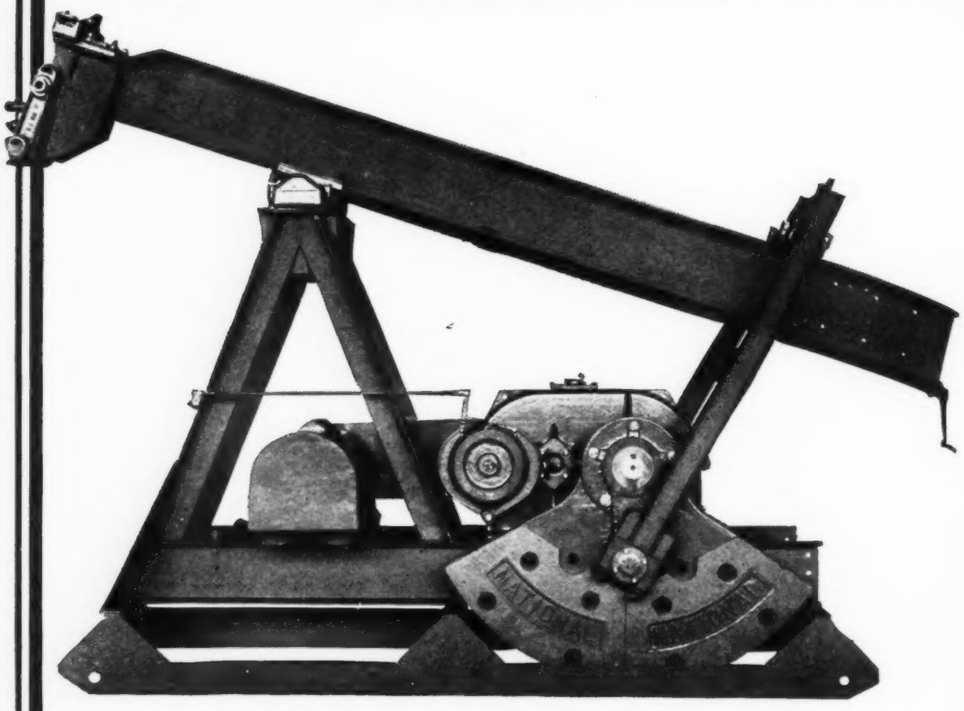
Retractor beam

Double pitman

Twin counterweighted cranks

Roller bearings

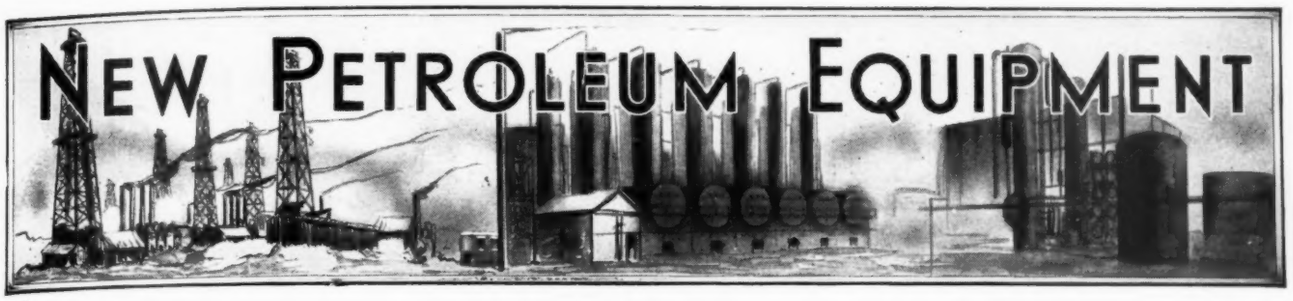
Service brake



A complete, compact, self-contained Pumping Unit of modern design and rugged construction, adaptable to any type of prime mover.

Descriptive literature free on request

THE NATIONAL SUPPLY COMPANIES



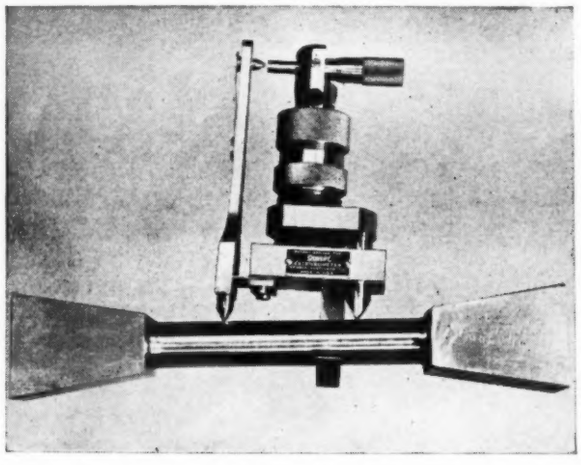
Small Limit Stop Has Standard Mill Contractors

A NEW small size crane limit safety stop, with standard mill type blowouts and contact tips, has been developed by Cutler-Hammer, Inc., Milwaukee, Wis. These stops are used to prevent over-travel of the hoist on electric cranes.

Rated for 40 horsepower and under, it is claimed the new stop is unusually small and compact for this rating, taking only nine inches head room. The stop is supplied complete with leads equipped with soldering lugs. The cover is removable for inspections and repairs.

The Oxweld Extensometer

THE OXWELD EXTENSOMETER, a new testing device which makes it possible to determine the yield point of specimens being tested in an Oxweld Portable Tensile Testing Machine, has been announced by The Linde Air Products Co., 30 East 42nd St., New York City.

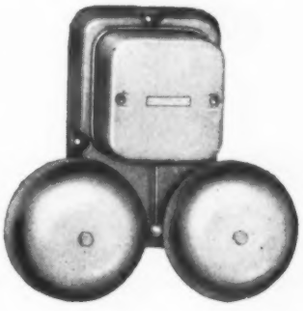


The sensitivity of the Oxweld Extensometer is such that it will indicate the elongation in a standard A. S. T. M. test specimen occasioned by the heat of the human hand. Although highly sensitive, this precision instrument is simple, rugged, self-contained and self-compensating.

The two points of the Oxweld Extensometer are clamped on the specimen to be tested in such a manner that the elongation between the two points during tension is multiplied in a ratio of five-to-one by a lever bar making electrical contact with the micrometer head. The moment of contact is indicated by the flash of a small electric light in the extensometer head. This exclusive feature makes it possible for a single operator using the Oxweld Portable Tensile Testing Machine in combination with the Extensometer to determine both the ultimate strength and the yield point of a specimen.

Weatherproof Loud-Ringing Telephone Extension Bell

THE "65" type Kellogg loud-ringing extension bell, designed and manufactured by the Kellogg Switchboard and Supply Company of Chicago, is one of the latest developments in the telephone field, and is unusually well adapted for use in oil fields. It is sturdily constructed of selected materials and will give many years of reliable service with little or no maintenance.



The Kellogg extension bell is especially designed to meet every telephone service requirement for indoor or outdoor use, on either common battery or magneto lines. Completely weatherproof, it operates perfectly under any climatic condition.

Only two connections are necessary to install the bell. It is wired directly to the desk set box or line, so that any ringing signal coming over the telephone line immediately operates the bell. The six-inch steel gongs are scientifically designed and produce a loud clear ring. They have a durable weatherproof finish and are of eccentric design for easy adjustment.

The weatherproof housing consists of a heavy cast iron base with removable cast iron cover, held in place by two screws. The bell can be mounted in a few minutes with three ordinary screws or bolts.

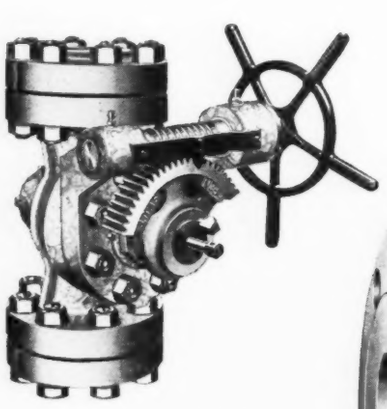
"Oilwell" A.P.I. Pull Rods

THE OIL WELL SUPPLY COMPANY is marketing a new pull rod and clamp that are dimensioned exactly to the latest A.P.I. specifications. These A.P.I. rods are made of high-tensile steel, with the ends carefully and accurately upset. The upset ends provide a greater cross section, and consequently greater strength and longer service.

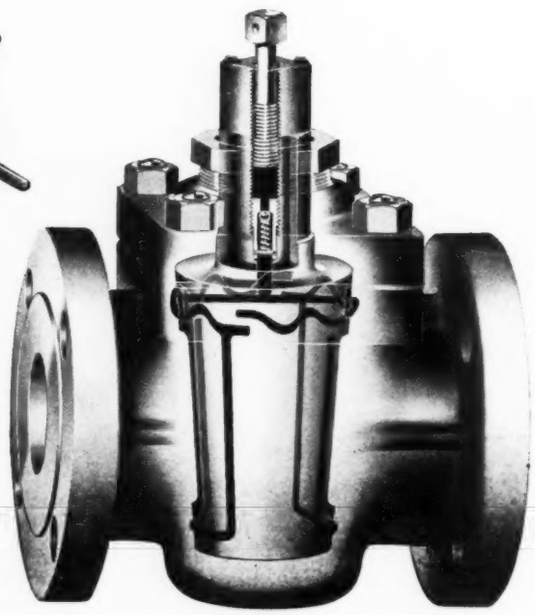
The A.P.I. clamps are of steel and are drop forged; because their minimum cross-sectional area is several times that of the rod body, the clamps are considerably stronger than the rods. It is to be particularly noted that the bolts for the clamps strictly conform to A.P.I. requirements; the ¾-inch size has a ⅞-inch x 3½-inch bolt and the ⅞-inch size has a 1-inch x 3⅞-inch bolt.

And for still greater strength the upset ends of these new A.P.I. rods are normalized. This pyrometer-controlled operation relieves all forging strains and refines the grain structure.

It is claimed by the distributors that the new "Oilwell" A.P.I. pull rods and drop forged A.P.I. clamps lead the field in design and in strength.



Series 90 Cast Steel Lubricated Plug Valve



Sectional view—Iron Body Lubricated Plug Valve

The experience of sixty years in the manufacture of cocks, and seventy-seven years in the manufacture of valves, has been incorporated in the design of a new line of Lubricated Plug Valves.

CRANE

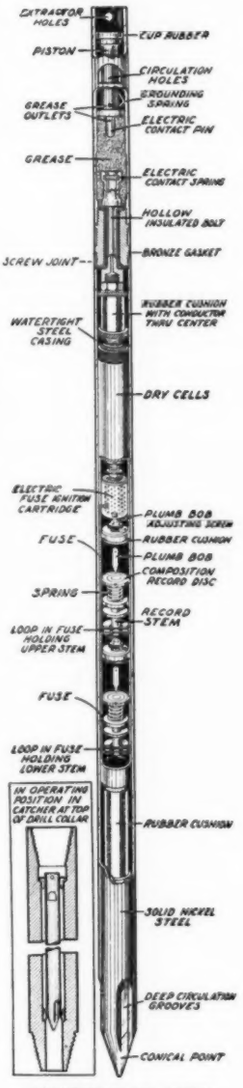
CRANE CO., GENERAL OFFICES: 836 SOUTH MICHIGAN AVENUE, CHICAGO
NEW YORK: 23 WEST 44TH STREET
Branches and Sales Offices in One Hundred and Seventy Cities

The Anderson Go-Devil

A NEW type of go-devil for measuring inclination of a drilling well has recently been developed by Alexander Anderson of Fullerton, Calif. A special sub or catcher is inserted at the top of the drill collar to receive the go-devil when it reaches the bottom of the drill pipe. It automatically indicates to the driller when it has reached the catcher; the drill pipe must then be held stationary for only two minutes while the apparatus is making a record of inclination; circulation holes are provided to prevent any impediment to circulation through the drill pipe. Two separate permanent records are obtained every time the go-devil is run and when these two records are identical, both plumb bobs must have been at rest, leaving no chance for an erroneous reading.

The recording mechanism of the instrument slips inside a watertight casing and is protected by a rubber cushion at each end. This mechanism includes two identical recording units and each unit includes a plumb bob suspended above a circular record disc. Each record disc fits into the top of a holder which resembles a valve with a stem and spring beneath it. The lower end of each record stem has two notches in it which are arranged to hold a loop of fuse.

At the top of the recording mechanism there is a chamber for holding two small dry cells. Below this is a clip for retaining an electric fuse ignition cartridge.



ANDERSON GO-DEVIL

Byron Jackson Hydropress Pumps

BYRON JACKSON COMPANY, pump division, Berkeley, Cal., has designed the Hydropress Pump for use in low capacity delivery field. The pump is being manufactured in three, five, seven and one-half and ten horsepower, sixty-cycle machines.

The three and five horsepower units will be direct connected, operating at 3600 r.p.m., handling from ten to thirty gallons of fluid per minute. As a driver for these pumps, the 3600 r.p.m. Wagner rotors and stators are being used.

The pump proper is built along the lines of the Byron Jackson double case, hot oil pumps, thus embodying the feature of a simple cylindrical outer case with one circular joint, permitting the use of a longitudinally split inner case, held together by the external pressure of the case, which is higher than the internal, and a few light bolts which are used only for mounting. The impellers are mounted on the shaft in advance, and the whole rotating element statically and dynamically balanced. The outer case insures mechanical simplicity and safety, leaving the function of the inner case mainly that of assuring high hydraulic efficiency.

The inner volute of the three-horsepower pump will consist of ten stages, and the five-horsepower pump of sixteen stages.

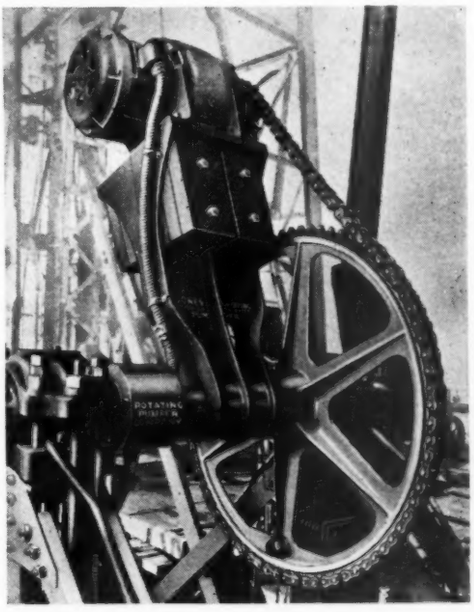
The seven and one-half and ten-horsepower pumps are designed for gear drive, operating from 1750 r.p.m. motors to pumps of 5000 to 5900 r.p.m. The standard construction in this unit employs a Sterling Cross-Line motor and gear. The ten-horsepower machine develops pressure in the order of 500 pounds and the seven and one-half-horsepower develops 375 pounds. Both of these units can be used for capacities of ten to thirty gallons per minute.

Jones Rotating Pumpers

THE JONES ROTATING PUMPER, as its name implies, is a pumping unit in which the mechanism revolves with the crank. Fundamentally the purpose accomplished is the utilization of the weight of the driving equipment for counterbalancing effect.

The prime mover unit consists of a weatherproof, General Electric cross-line start motor with a heavy duty Pacific double reduction gear. The motorized gear is mounted radially on the counterbalance arm, which arm is keyed solidly to the crank shaft. This arm, whose machined end forms the motor and gear foundation, is also designed to have extra cast iron weights bolted to it for adjustable counterbalance.

The forged steel cut pinion sprocket, of the size required to give the desired speed, mounted on the reduction gear shaft, drives through roller chain to the main or fixed sprocket, which is concentric with the crank shaft. Since this main sprocket is anchored against rotation it forms a complete track around which the driving pinion causes the motorized gear and counterbalance arm to rotate. The arm, of course, in turn, rotates the crankshaft in the bearings and in the hub of the main sprocket.



There is sufficient capacity on this unit to balance the heaviest well. It applies to any well, is applicable to existing standard ends, or may be installed on its own foundation. If separate means are not available for pulling the well, the pumping motor, in the larger size units, is arranged for well servicing operations. On shallow wells, where the duty is equivalent to 4000 feet or less, using two and one-half-inch pump, the unit is provided to fit onto the existing band wheel shaft and crank. For deeper wells and heavier duty, a special shaft is furnished and recommended by the manufacturers, Rotating Pumper Company, 1333 Santa Fe Avenue, Los Angeles, Calif.

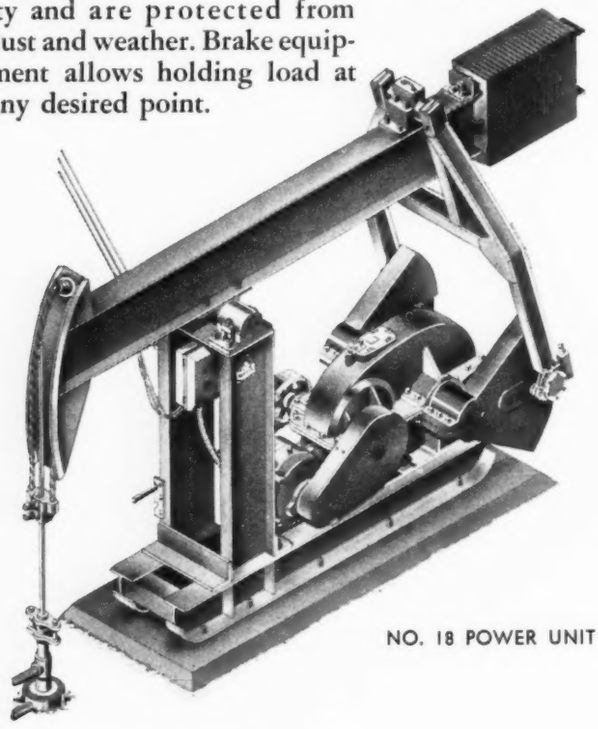
NORRIS
ECONOMY POWERS

For Single Well NO. 18 POWER UNIT
For Several Wells BULL PUP POWER UNIT

Norris Pumping Units are designed to meet the most exacting field conditions, being sturdy and compact of arc welded construction. It has strength to withstand the momentary overloads that are so often imposed on oil field equipment.

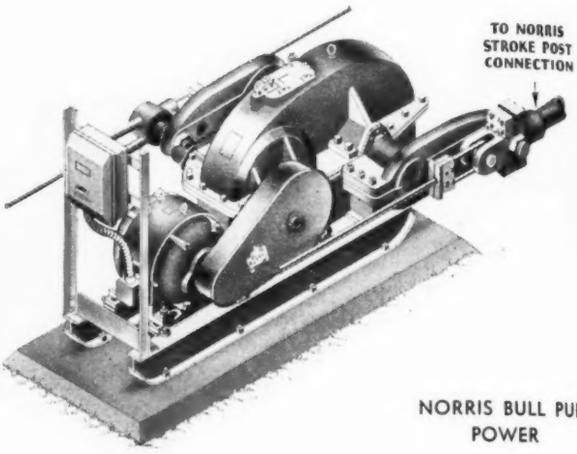
A motor of special construction for oil field pumping with extremely high overload capacity, insures satisfactory long service with freedom from breakdown tieups. Furnished either with electric motor or four-cylinder gas engine.

V-Belt drives furnish convenient method of changing speed ratio. Beam bearings are of large size equipped with oil reservoirs of ample capacity and are protected from dust and weather. Brake equipment allows holding load at any desired point.



NO. 18 POWER UNIT

Swaged Nipples-Bull Plugs, OK Pumping Jacks, Norris Little Giant OK Jack, Iron Swings, Super Strong Pull Rods, Combination Clamps, "Knock Off" Blocks and Hooks, Hold Down Castings, Polish Rods, Working Barrels and all surface equipment; Norris Heavy Casing Anchor and Tubing Clamps; Pumping Outfits complete.



NORRIS BULL PUP POWER

The Norris Bull Pup Power Unit is an economical power unit for pumping a limited number of wells. With electric motor drive, four take-offs are possible. With gas engine drive three take-offs are possible.

Furnished with Norris regular wrist-pin connections providing for C. C. Clamps to rod lines, or if desired, Norris combination wrist-pin connection with 4-inch pipe threads in one end for use with Norris stroke post or multiplier hook-up.

This power is strictly weatherproof and is equipped with the same high grade motor and gears as used on our individual pumping unit. It can be economically installed at any location on your lease, and in connection with W. C. Norris pump jacks, it affords the most economical method of pumping oil wells.

Write for complete detailed information, weights and prices of either of these two economy powers or any of the other oil field and pumping equipment we manufacture.

W C. NORRIS
MANUFACTURER

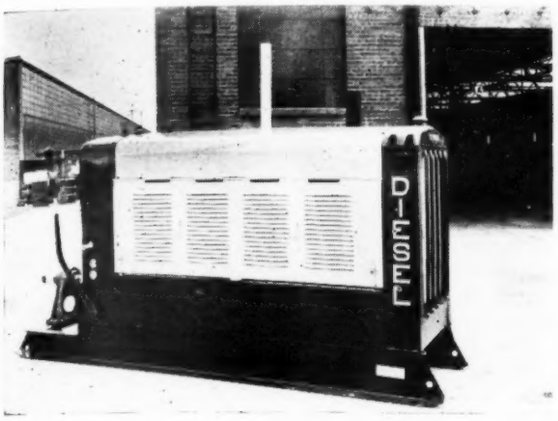
TULSA, OKLAHOMA

KILGORE • FORT WORTH • HOUSTON, TEXAS

"Caterpillar" Stationary Diesel Ready

THE DIESEL ENGINE that has been developed by the Caterpillar Tractor Company, Peoria, Ill., after seven years of intensive research, is now to be made available to the stationary engine trade. It is now in production at the Peoria plant.

This engine has a 6⅛-inch bore, 9¼-inch stroke, and is governed at 700 r.p.m., developing better than 85 horsepower. It has four cylinders, is four-cycle, and uses the solid injection fuel system, and a pre-combustion chamber.



The fuel system of any Diesel is generally the determining factor in its successful and economical operation. This factor has received the most serious consideration of "Caterpillar" engineers and the outstanding performance of the "Caterpillar" Diesel is due to the simplicity, yet effectiveness, of its fuel system.

The solid injection method of handling fuel oil on this Diesel is by means of individual pumps mounted on each cylinder. These are accurately calibrated and sealed at the factory, thereby preserving the intended settings under operating conditions.

The fuel injectors have a single orifice of .086 diameter (2.3 mm.). A self-cleaning pintle keeps this orifice from clogging and maintains its prescribed dimension.

The fuel in a "Caterpillar" Diesel is first injected into a pre-combustion chamber, where it is ignited by heat generated by high compression.

This pre-combustion chamber prepares the fuel for the main combustion chamber in the form of a partly-burned rich, dry mixture, carrying no wet slugs, and therefore minimizing crankcase dilution and preserving lubrication on the cylinder walls. Another quality is the fact that this pre-combustion chamber permits burning a wide range of fuels.

The engine is provided with a positive starting mechanism —a small two-cylinder, four-cycle gasoline engine, mounted on the side of the Diesel itself. The engine is water cooled, being connected to the Diesel cooling system. The exhaust gases of this starting engine warm the Diesel intake for ease in starting. The starting energy is imparted to the Diesel engine through a clutch and Bendix drive to the Diesel flywheel.

The fuel saving of this Diesel over a gasoline engine of comparable horsepower is very pronounced—and works two ways. The number of gallons of fuel oil used per hour is about one-half the number of gallons of gasoline used. And the cost of the fuel oil per gallon is ordinarily from one-third to one-half the cost of gasoline. On studies that have been made of these Diesels that have been operating on the same work where gas engines of similar horsepower were used, the saving per day in fuel alone amounted to more than $5.00.

It is expected that Diesel engines of this size will be adaptable to a wide range of commercial uses to replace antiquated power of other types.

Then, too, this "Caterpillar" Diesel is in the power range of a wide marine demand. Its pronounced economy of operation, its sturdy construction, and its reputation to "keep going," equip this engine with the desirable qualities for both fishing boats and pleasure craft.

New Cutting Attachment for Welding Torch

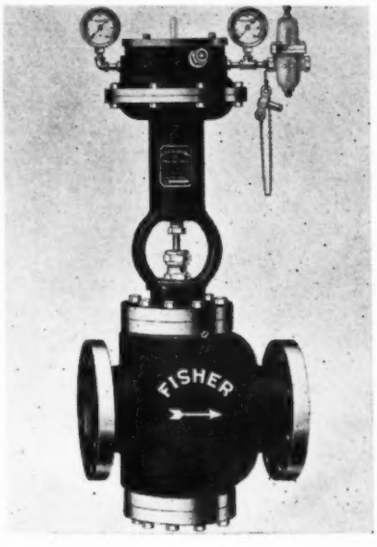
TO accord with the economic requirements of manufacturing under present conditions the Smith Welding Equipment Corporation, 2619-33 Fourth Street, S. E., Minneapolis, Minn., has placed upon the market a new cutting assembly, or attachment, for a welding torch called the "Money Saver" cutting assembly. To maintain the efficiency of the cutting assembly and yet to manufacture it at a considerably less cost was the problem involved.

In designing this cutting assembly the engineering department eliminated every customary feature usually considered necessary in the manufacture of such apparatus, such as levers for the cutting oxygen, adjustable unions to change the position of the assembly in the handle, etc., and substituted for these features valves of the greatest simplicity.

The cutting oxygen valve is a triple thread, screw valve with knurled thumb wheel, so arranged that it can be quickly opened and closed with the thumb. The valve forging has been reduced to the simplest possible design, the cutting tip automatically evens up the flames. Double seats and all other parts, not absolutely essential to operation, have been eliminated, resulting in simplicity of construction and manufacturing costs far less than the conventional type of cutting assembly. The new assembly has been approved by the Underwriters' Laboratories.

Fisher Governor Pilot Unit

THE FISHER GOVERNOR COMPANY has just announced the development of the Series 4200 Wizard Pilot Unit, that involves a new design which includes the pilot valve as an integral part of the main valve top work. This unit utilizes auxiliary air or gas as an operating medium and is suitable for all pressure conditions of five pounds and up.



The unit is easily converted from a pressure reducing valve to a pressure relief valve by a very simple change made in the pilot valve. It is furnished complete with a small auxiliary regulator and with a pressure gauge.

At the present time, this unit is being used extensively in many refinery operations where extremely close limits of regulation must be maintained. With the new design incorporating the pilot with the main valve, the elimination of time lag has been accomplished.

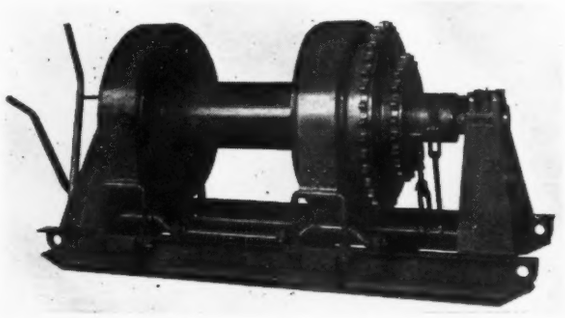
A new bulletin has just been issued on this Wizard Pilot. It will be gladly sent to any one interested by the Fisher Governor Company, Marshalltown, Iowa.

A New Tubing Hoist by National

THE NATIONAL SUPPLY COMPANIES announce their new Type CF Tubing Hoist, of modern design, light weight and extremely rugged construction. It has been developed to meet the demand for a stronger hoist of this type, and is particularly suitable for concrete derrick floor installations.

It is a compact, self-contained friction clutch unit with a rated line pull capacity of 18,000 pounds, and suitable for use with non-reversing prime movers through either standard rigs or reduction gears.

The frame is of all-steel welded construction, exceptionally strong and rigid. Bearing boxes welded in the frame are permanently in line.



One of the unique features of this hoist is the electric welded steel drum, light in weight but possessing excess strength. Because of the welded construction, flanges cannot spread, and the drum unreels freely with a light line load.

Two demountable, cast iron brake rims are bolted to the drum flanges, providing ample braking capacity for lowering rods or tubing with speed and safety. The single cone type clutch is designed to transmit high torque with low unit pressures. Hycoe lining is used for both brakes and clutch.

Alemite lubrication is used throughout.

The Type CF Hoist offers, at a moderate cost, ample capacity, great convenience and extreme serviceability.

Roots-Connersville Will Manufacture Purging Machine

ROOTS-CONNERSVILLE-WILORAHAM, Connersville, Ind., have made arrangements with A. D. Harrison, Brooklyn, N. Y., to manufacture the purging machine designed by Mr. Harrison, which has been used by several of the large Eastern gas companies during the past two years in purging holders, mains, etc.

This purging unit will be sold under the name of R. C. W. Harrison Purging Machine, and the manufacturers point to a wide and growing need for a machine of this type, not only in the gas industry, but also in the oil and chemical industries, among others.

R. C. W. Harrison Purging Machines are built to produce inert gas containing less than 1 per cent oxygen, and free from carbon monoxide gas, when operating from manufactured or natural gas.

The machine is usually furnished mounted on a highway trailer to provide portability. It consists of an R. C. W. Blower and an R. C. W. Gas Pump, handling air and gas respectively. The air and gas are delivered separately to a water-cooled combustion chamber where the gas burns, forming the inert gas which is discharged through a cooler to bring the temperature down to a useable point. The power unit can be either an electric motor or a gas or gasoline engine.

An air injector is provided in the line leading to the gas pump through which the additional air necessary for complete combustion is induced. This permits control of the machine when the theoretical air-gas ratio changes due to changes in the gas.

Since the air and gas are not mixed until they reach the burner, there is no possibility of a back-fire. An electrically ignited pilot is provided to light the burner.

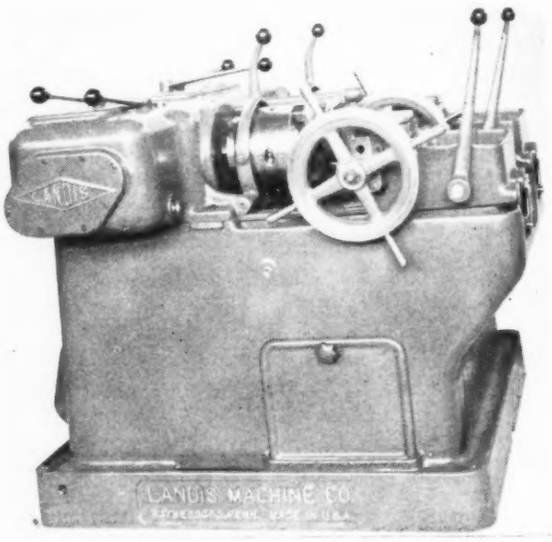
R. C. W. Harrison Purging Machines have been built in two sizes, rated respectively at 15,000 and 35,000 cu. ft. of inerts per hour, measured at 60 degrees Fahrenheit against 2 lbs. discharge pressure. Other capacities and pressures can be arranged for, if required.

The 1¼-Inch Landmaco Pipe and Nipple Threading Machine

THE LANDIS MACHINE COMPANY, INC., at Waynesboro, Pa., announces the one and one-fourth-inch Landmaco Pipe and Nipple Threading Machine, designed to meet the demands of nipple manufacturers for a modern threading machine with exceptional wearing qualities and a capacity for producing nipples of great accuracy at a low cost.

The machine is made in the single and double head models and is equipped with either externally or internally tripped Lanco pipe and nipple threading heads. Its range is from one-eighth inch to one and one-fourth inch with the externally tripped head and one-fourth to one and one-fourth inch with the internal type.

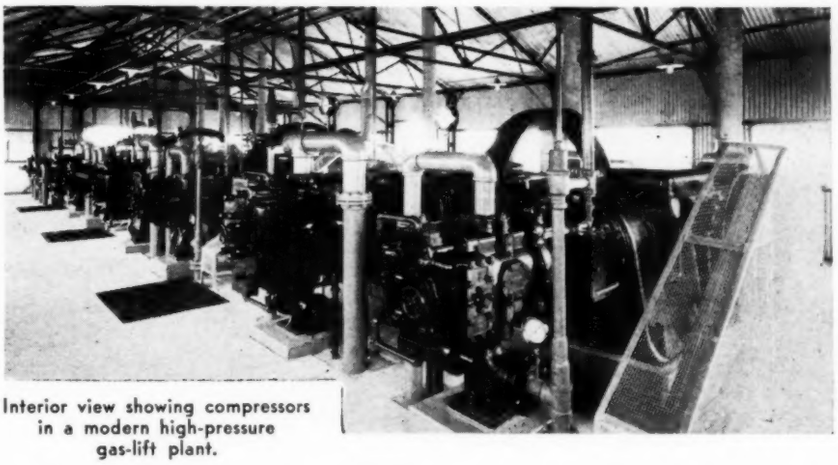
A single pulley drive with a friction clutch control delivers the power to the machine. The clutch is mounted on the outer end of the drive shaft where it is accessible for the ordinary maintenance adjustments. The machine can be motorized at any time by mounting a suitable motor in the motor compartment in the bed and connecting it to the drive shaft with a silent chain.



The gear box is of selective type with eight speeds. The spindle is driven by spiral bevel gears. The bearings at the die head end are over-size, pre-loaded, anti-friction type. The die head is located close to the front spindle bearing to reduce the overhang to a minimum. It may be opened or closed either automatically or by hand.

Tapered Tubing and Gas-Lift as Applied to Texas Operations

THE use of tapered tubing as a flow string is a comparatively recent refinement in gas-lift practice. Its use has been pioneered in Texas in the last three years, and the results obtained are significant. That it has had a very limited application up to now can be traced to the fact that for reasonably consistent success the design of a tapered flow string must be based on theoretical fundamental principles of gas-lift flow and a proper analysis of well and sand conditions. Well and sand conditions are usually open to a wide interpretation because of a lack of precise knowledge of the many factors involved. To those who have a good understanding of the principles of gas-lift flow, and have been active in applying these principles to every-day field practice, the status of tapered tubing as a piece of producing equipment in an oil well is therefore considered to be in a most rudimentary stage of development. If this be true, the more widespread application of tapered tubing for flowing wells is assured.



Interior view showing compressors in a modern high-pressure gas-lift plant.

A tapered string properly designed to meet the well conditions should result in a more efficient use of gas energy. Where the well conditions are favorable to the use of tapered tubing, the well can be produced more efficiently at lower rates of flow and with a lower gas-oil ratio than is possible with a flow string of straight tubing. Proration of oil production has stimulated the interest of oil producers in the possibilities of tapered tubing and to this fact can be attributed the progress that has been made in pioneering its application in the fields of Texas.

Probably the most interesting results in the State have been obtained in West Texas. Here much work of a pioneer nature has been done in adapting tapered tubing to flowing wells. In the Yates field a series of tests were made on nine wells on the Tippett lease of the Shell Petroleum Corporation. Up until about the beginning of 1930, wells in this field had been produced by flow through the casing under pressure control. Choking at the surface by means of an adjustable flow bean was the standard method of maintaining back-pressure and controlling the rate of flow.

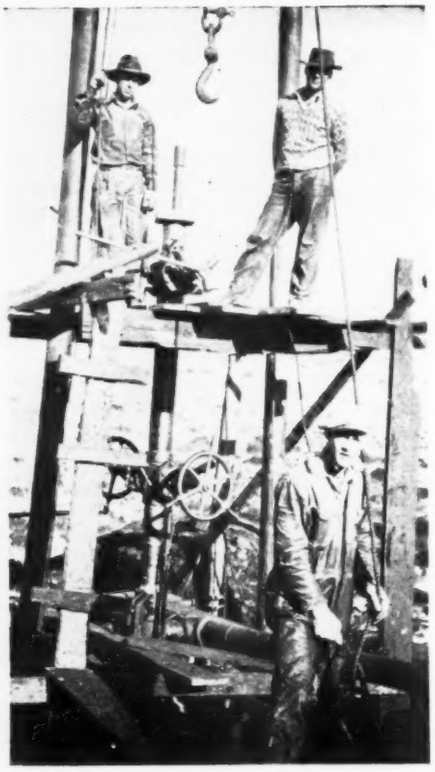
Gas-oil ratios in the field varied from 100 cubic feet to 8,000 cubic feet per barrel. The presence of water and the fact that the producing formation is limestone made it desirable to carry as high a bottom-hole pressure as possible. Although the average gas-oil ratio for the field was about 500 cubic feet per barrel, this was considered too high by many operators. Tubing of wells was therefore resorted to in an effort to obtain a more efficient flow.

Fortunately, when engineers of the Shell Corporation, in late 1929, decided on trying tapered tubing in their wells, a fairly complete record of the producing history of each well for 18 months back was available. These records, together with all available information on underground conditions were given considerable study. From this study and other experience data, they were able to design for each well a tapered string to suit the well conditions.

Tests were made on nine wells of the Tippett lease. Depths to the top of the pay sand in these wells range from 1,230 feet to 1,514 feet, and the total depth from 1,397 feet to 1,703 feet. All have been completed with a 6⅝-inch casing. Casinghead pressures before tapered tubing was installed ranged from 320 pounds to 590 pounds and the allowable well productions from 88 barrels to 420 barrels per day. Gas-oil ratios on continuous flow through casing at these flow rates ranged from 500 cubic feet to 6,400 cubic feet per barrel. The ranges in sizes of tubing, lengths of section and total lengths of tapered flow strings used were as follows: tubing from four-inch diameter to one-inch diameter; length of section from 336 feet to 564 feet; and the total length of flow string from 1,236 feet to 1,653 feet. In each flow string three tubing sizes were used, two-inch, one and one-quarter-inch, and one-inch in the smallest flow string, and four-inch, three-inch and two-inch in the largest flow string. Tubing was set off bottom at an average distance of 45 feet except in one well where a tight hole necessitated leaving the tubing 161 feet off bottom. Tubing was run in the wells between the dates of December 23, 1929, and February 23, 1930. Interruption of the well's production was obviated by running the tubing in the wells under pressure.

Friction and slippage are the two factors that enter into the efficiency of flow of a gas-oil fluid in tubing. At high velocities friction losses become excessive and losses due to slippage negligible; at low velocities slippage losses become excessive and losses due to friction negligible, hence the problem of design resolves itself into one of obtaining an optimum velocity in the flow string from bottom to top. The fact that gas expands, between the bottom of the well and the surface means that its volume has increased by the time it reaches the surface. If, therefore, the flow velocity is to be kept within the desired practical limits throughout the total length of the flow column the cross sectional area of the flow string must be increased from bottom to top in such a way as to attain this end.

Even with all factors entering into the problem accurately known, the determination of the optimum velocity is highly



Snubbing Tubing into a well in the Yates Pool.

involved, hence, it must be realized that with the paucity of accurate basic data that exists, approximations based largely on experience data must be made. This was the method pursued in the design of the flow strings for these test wells.

In the first installation the flow string was purposely made amply large, consisting of approximately equal sections of four-inch, three-inch and two-inch diameter tubing. Despite this fact, however, remarkable results were obtained in the reduction of gas-oil ratio. A steady flow at the allowable rate of production was obtained with a gas-oil ratio of 558 cubic feet as compared with a gas-oil ratio of 1,800 cubic feet when flowing at the same rate through the casing. This represents a conservation of gas (and its available energy) in the amount of 1,242 cubic feet per barrel of oil produced. Another advantage was the higher bottom-hole pressure that resulted from more gas being retained in the sand, thus further retarding water encroachment. In the other eight wells, the tubing strings of which were designed for maximum flowing efficiency under the existing conditions at the individual well, the results were quite satisfactory. Tests were made on each well at various rates of flow, the rate of flow being controlled by means of an adjustable choke in the tubing head. Two wells showed a wide variation in gas-oil ratio at different rates of flow, while in the other wells the gas-oil ratio was only slightly changed by varying the rate of flow.

In one of the two wells mentioned, the gas-oil ratio was 227 cubic feet when flowing at the rate of 30 barrels per day and 2,150 cubic feet when flowing 5,880 barrels per day. The suggestion is offered by the engineers who made these tests that conditions in the producing sand in the immediate vicinity of the well may play a dominant part in the control of gas-oil ratios.

The net result obtained by the use of tapered tubing in these nine wells was a reduction in gas-oil ratio of 86 per cent.

A comparison of the results obtained in the reduction of gas-oil ratio by using straight tubing with the reduction obtained by using tapered tubing on a group of 55 wells in the Yates field show that the reduction in gas-oil ratio with tapered tubing was twice that obtained with straight tubing.

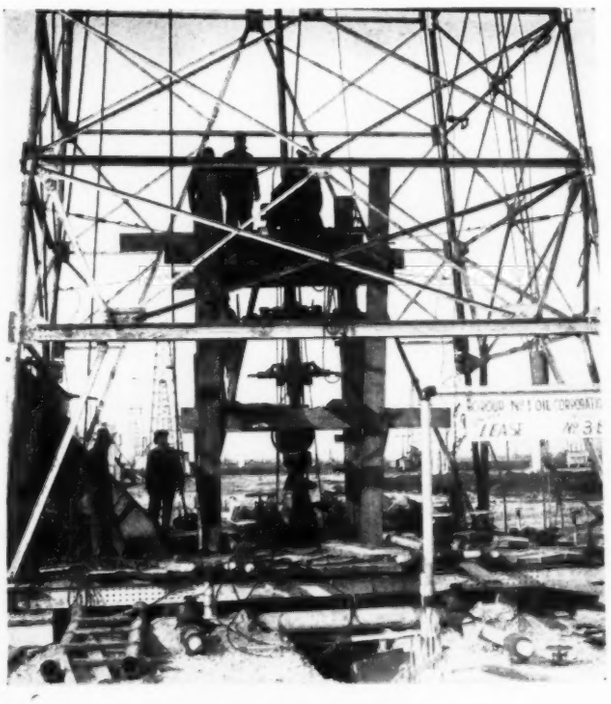
If there are dry gas horizons above the sand it is the practice in the Yates field where possible, to place the tubing deep enough in the fluid so that the bottom will be under a slightly higher pressure than that in the dry gas horizons. In this way the dry gas is prevented from entering the tubing and impairing the flowing efficiency of the well.

While the results in this field cannot be used as a standard of what can be accomplished in the average well, they do show that the proper use of tapered tubing to flow wells has a much wider application than is generally believed.

Outside of the work done in the Yates field the use of tapered tubing in flowing wells is now being applied with successful results in other fields in the State. It is evident that proration has been responsible for arousing interest in its application to the producing of wells at a low daily rate of flow. In West Texas, tapered tubing is being used today to flow wells at a rate as low as 10 barrels a day, and tubing of less than one inch internal diameter is being used in the tapered flow string. Detailed information on many of these operations is not readily available.

Where gas-lift is being used to flow a number of wells and there is a gasoline plant in the field, it has become customary to compress the gas at the gasoline plant rather than at a separate gas-lift compressor plant.

Gas-lift is still in use in a number of fields. Proration restrictions, however, has cut down the number of other methods of production.



Running tubing under pressure in deep West Texas well without killing well.

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The Government's Helium Projects in Texas

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C. C. ANDERSON☆

TEXAS, famous for its petroleum and natural gas resources, is noted as a producer of helium, the non-inflammable lifting gas used in the lighter-than-air craft of the military services. Large-scale production of helium is closely associated with the oil and gas industry, since natural gas, containing about one per cent or more of helium, is the only source material from which large quantities of this gas have been extracted. Most gas fields in the United States produce helium-bearing natural gas, but very few have sufficiently high percentages of this constituent to make extraction practical and economical under present conditions. Some of the fields of Texas produce gas containing economically important percentages of helium, and since two of these have at one time or another offered sufficient possibilities for development, the Government erected plants to process the gas from them.

The first large-scale Government helium plant, which was the outgrowth of experimental work initiated and directed by the Bureau of Mines and financed by the Army and Navy during and following the World War, was erected at Fort Worth, Texas. This 5-unit plant employed a helium-extraction process designed by the Linde Air Products Company, which was one of three commercial concerns co-operating in the experimental work. Operations of this Fort Worth plant were started in April, 1921, under the supervision of the Navy Department, and the plant remained under the administration of that department for more than four years. The jurisdiction of the plant was transferred to the Bureau of Mines, Department of Commerce, on July 1, 1925, and its operation was continued to Jan. 10, 1929. During its existence, the Fort Worth plant ran successfully for 83 months and produced about 46,000,000 cubic feet of helium.

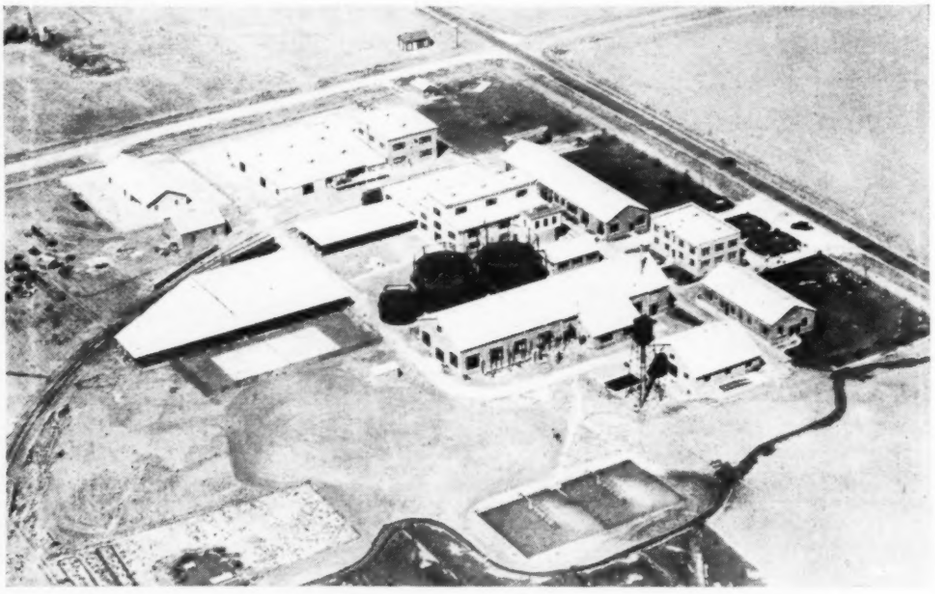
The supply of helium-bearing natural gas for this plant was obtained from the Petrolia gas field of Clay County, Texas. The gas-producing horizon of this field was discovered in October, 1907. A pipe line was laid from the field to Fort Worth and Dallas, Texas, in 1909, and from 1911 to 1918 the field constituted the principal source of gas supply for cities of north Texas. During that period the average daily withdrawal was over 21 million cubic feet. After a thorough investigation, in 1915, the Petrolia gas field was considered capable of supplying this demand for a few years, but in case new production was not discovered, the output in 10 years would probably be too small to be worth transporting.[1]

However, from data collected very hurriedly during the war period, the petrolia gas field, although considerably depleted by that time, appeared to be the largest known source of helium-bearing natural gas.[2] Therefore on Jan. 10, 1919, the Navy Department entered into a ten-year contract to take this gas for helium extraction and the company operating the field agreed to limit the daily production to 10,000,000 cubic feet. The reduced rate of withdrawal and the discovery of gas in the Martin extension area prolonged somewhat the producing period of the field. However, by 1925, it was evident that the field was so rapidly reaching the final stages of depletion that unless new reserves of helium-bearing natural gas could be obtained in the near future, the cost of producing helium would soon become prohibitive.

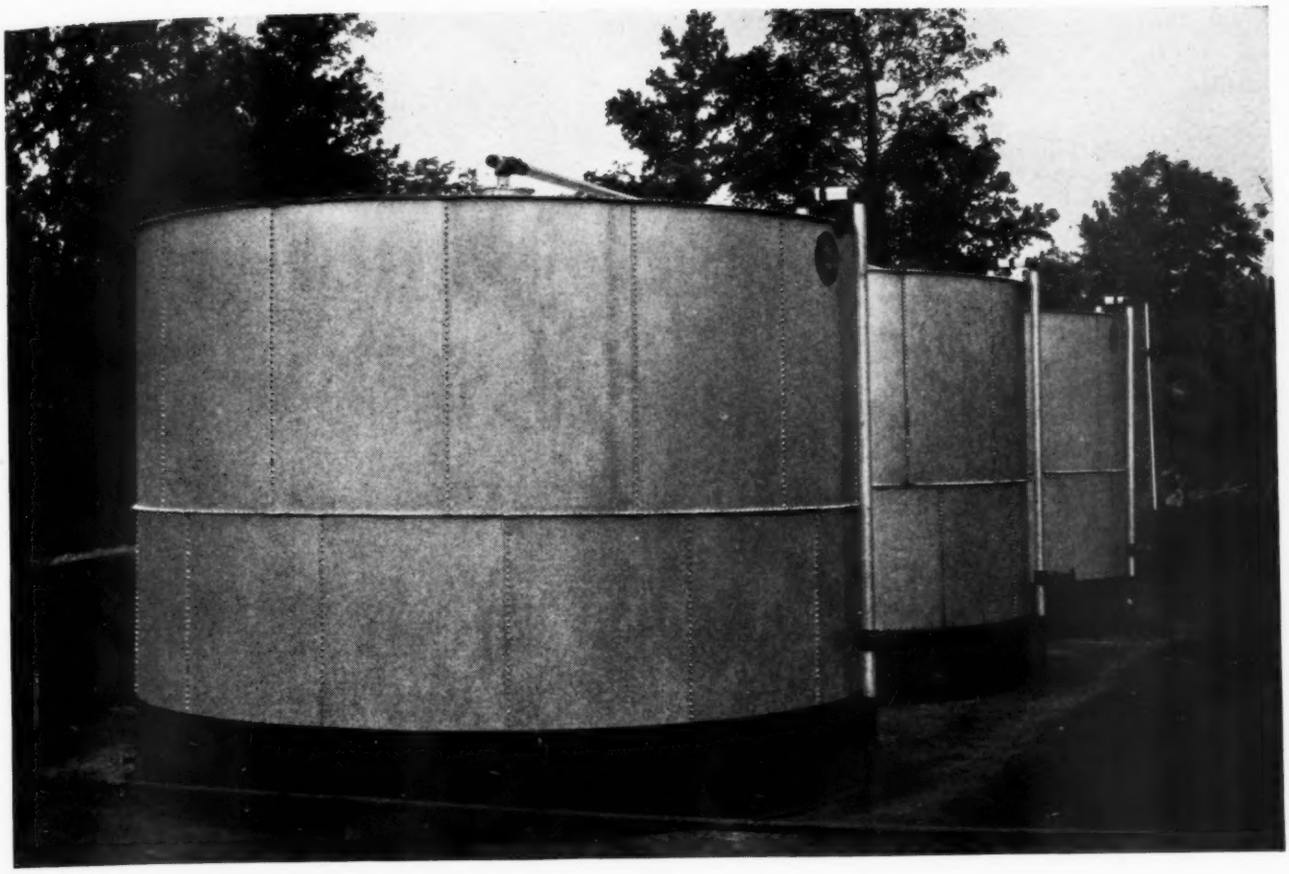
From the inception of the Government's helium activities, the Bureau of Mines has maintained an active survey to locate and estimate the helium resources of the nation. By the time the Fort Worth plant was anticipating a shortage of natural gas supply, over 3,000 gas samples from practically all of the gas fields of the United States had been analyzed. The infor-

☆ Associate Chemist, U. S. Bureau of Mines, Cryogenic Laboratory, Amarillo, Texas.

[1] Shaw, E. W.; Matson, G. C., and Wegemann, C. H., Natural Gas Resources of Parts of North Texas; U. S. Geological Survey Bulletin 629, p. 74.
[2] Rogers, G. Sherburne, Helium-bearing Natural Gas: U. S. Geological Survey Prof. Paper 121, p. 85.



U. S. Bureau of Mines Helium Plant, Amarillo, Texas. Photograph by Air Corps, United States Army, Fort Sill, Okla.



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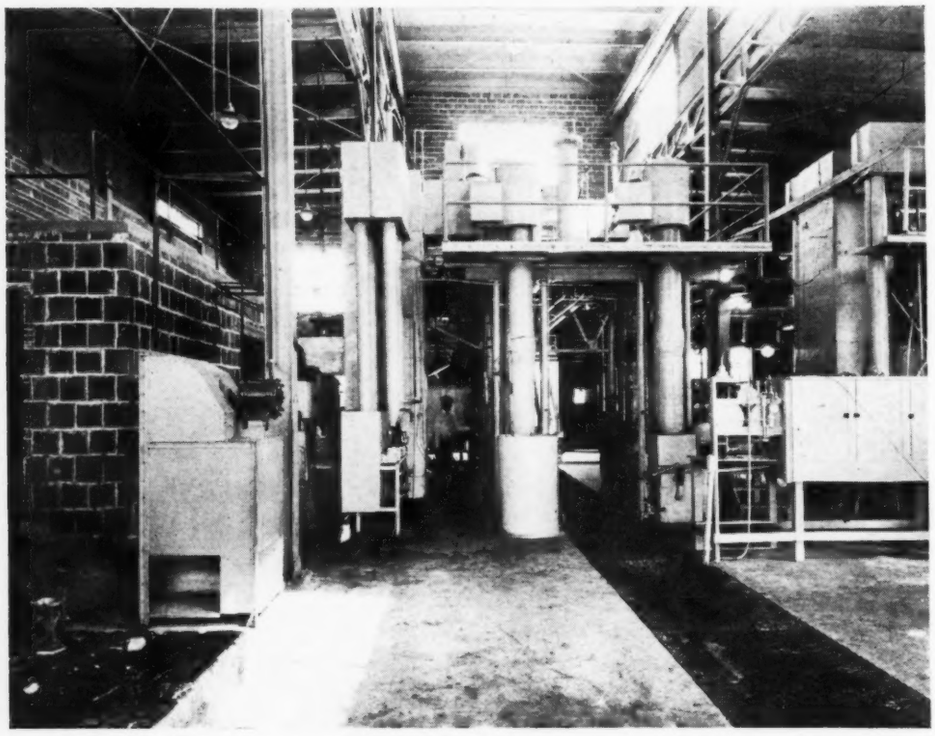


Helium Separation Building—Showing separation and purification units.

mation derived from this survey facilitated the work of selecting the more promising areas which needed further investigation as a probable future source of supply.

A desirable helium content was, of course, the prerequisite required by the Government. It desired, in addition, to secure a virgin gas field having a high rock pressure, sufficient gas reserves to insure long operation of a plant and, if possible, to gain complete control of the gas rights. Obviously, this field should be reasonably close to a good plant site; having suitable railroad facilities, markets for residue gas, ample supply of good water, and many other essential features.

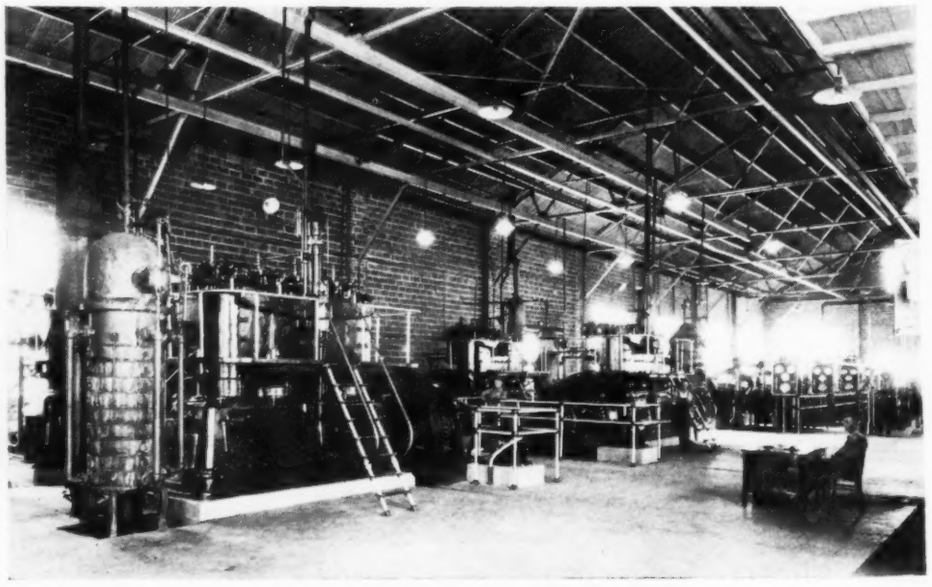
From various likely areas, the Bureau of Mines selected the Cliffside structure, or Bush Dome, located in central-western Potter County, Texas, for still further investigations. These were started in March, 1926. The structure was found to have axes several miles long and to be definitely separated from the main Panhandle gas-producing area by a fault of approximately 1,000 feet displacement. The gas rights were held by five interests and the existing leases were in large blocks of acreage. Two wells had been drilled, but very little gas had been removed, making the field practically virgin territory. The initial rock pressure was 723 pounds per square inch and the gas contained nearly 2 per cent helium. Besides these favorable conditions, the field was conveniently located with respect to a plant site.

Several other areas were given careful consideration. Among these might be mentioned the Nocona oil and gas field, located in Montague County, Tex., some twenty-two miles northeast of the Government's Petrolia-Fort Worth pipe line. Acreage in this field, however, was owned by a number of operators whose primary interest was in the production of oil. For this reason it appeared that the control of the gas production could not be maintained according to the Government's desires; hence, the project was rejected. The wisdom of this decision has since been borne out by the rapid decline in rock pressure of the field from 315 to less than 50 pounds per square inch.

The favorable data obtained by the examination of the Cliffside field led to negotiations for the acquirement of gas rights on about 50,000 acres by the Government. Under an optional agreement, two more gas wells were drilled on the area, which made four successful completions with a total open-flow capacity of about 30 million cubic feet. In view of the many favorable conditions, the Government proceeded with the acquirement of gas rights in the structure, so that at present the Government has practically complete control of it, thus insuring conservation of the helium-bearing gas for national defense.

In the meantime, an 18-acre plot, some seven miles west of Amarillo, Texas, was selected for the new helium plant site. This was later connected by a six-inch welded pipe line with the gas field located about eleven miles to the north. Ground was broken on the site in August, 1928, and the plant was rushed to completion.

By December, 1928, the Petrolia field had become so depleted that the Fort Worth plant could no longer be operated on an efficient and economical basis. Since the new Amarillo plant was well under construction and would be operating in a few months, the Bureau of Mines decided to close the Fort Worth plant on January 10, 1929. It was subsequently dis-



Power House—Gas-engine driven generator units.

mantled. Materials and standard equipment, such as gas-engines and compressors, which could be used in the new plant were shipped to Amarillo. The separation apparatus was purchased by the Linde Air Products Company in acordance with the contract under which it was installed. The remainder of the equipment was disposed of partly by transfer to other Government units and partly by sale. The Amarillo plant was in condition to start continuous production in April, 1929. This plant was designed by Bureau of Mines engineers, constructed under their supervision, and is operated by employees of the Bureau's Helium Division. The first helium shipment left the plant, for Langley Field, May 6, 1929.

The helium-bearing natural gas is delivered to the plant through the pipe line from the Cliffside structure at a pressure of about 600 pounds per square inch, which is sufficiently high to require no further compression during the process.

The process of helium extraction as used in this plant consists, in general, of three major steps, namely: removal of carbon dioxide from the natural gas, separation of the helium as a mixture of nitrogen and helium, and finally the purification of this mixture.

Removal of carbon dioxide from the gas is necessary as the first step in helium extraction. Failure to remove it would cause the formation of solid carbon dioxide during the separation process and result in plugging the equipment. This removal is effected by thoroughly scrubbing the natural gas with a 7 per cent solution of caustic soda. The reaction is carried on in a 1,000-foot section of four-inch pipe operating under full pipe-line pressure. The solution is forced into the scrubbing system by means of a piston-type pump, flows concurrently with the gas through the four-inch pipe, and discharges into a high-pressure separator which is similar in the results obtained to the type used so commonly in the oil fields for separating oil and gas. From the separator, the gas, still under 600 pounds pressure, goes to the helium separation unit while the caustic solution, automatically removed, is returned to storage tanks for reuse.

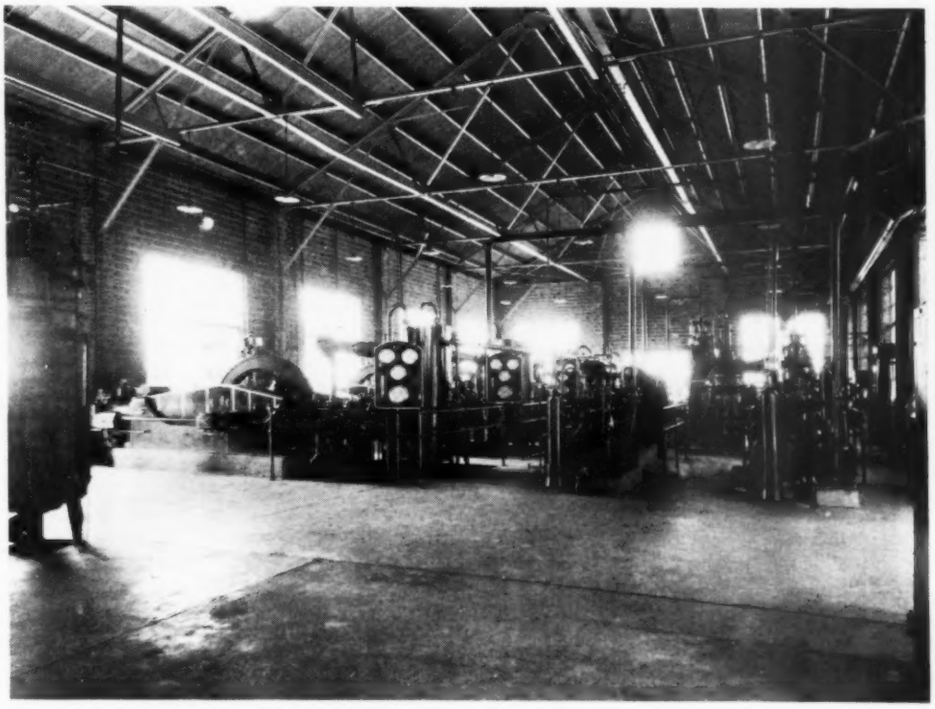
When the caustic solution becomes spent, it is recausticized by adding lime. This results in the formation of solid lime carbonate and a reformed caustic soda solution. The former is filtered off, leaving the solution to be returned to storage for further use in the system.

The natural gas from the above process, now practically free of carbon dioxide, enters the separation unit at about 600 pounds pressure and atmospheric temperature. Moisture is removed by condensation in a preliminary cooling step. The gas then passes through a system of heat interchangers, being progressively cooled by an exchange of heat between it and the processed gas flowing countercurrent under reduced pressure from the cold end of the cycle. This cooling of the incoming gas continues until a temperature of about 250° F. below zero is obtained, at which point the gas is largely liquefied and the remaining gaseous phase is withdrawn from the liquefied constituents in a specially designed separator. The gas withdrawn is termed "crude helium" and consists of approximately equal proportions of nitrogen and helium.

An auxiliary nitrogen-cooling cycle is maintained in order to furnish the refrigeration necessary to start the plant process and also to make up for heat losses while in operation. In this system, the nitrogen under a pressure of about 500 pounds per square inch, after having the heat of compression removed, is expanded in a small engine. This removes energy from the gas in the form of work, thus producing a cooling effect. The nitrogen entering the expansion engine is cooled progressively by the cold exhaust, until the desired refrigeration is obtained.

From the separation unit, the processed natural gas, after giving up its "cold" to the incoming gas in the interchangers, is discharged into a 10-inch pipe line and is sold as fuel gas. The crude helium-nitrogen mixture, amounting to something less than 5 per cent of the total gas volume coming to the plant, is sent to a gas holder from which it enters the purification cycle.

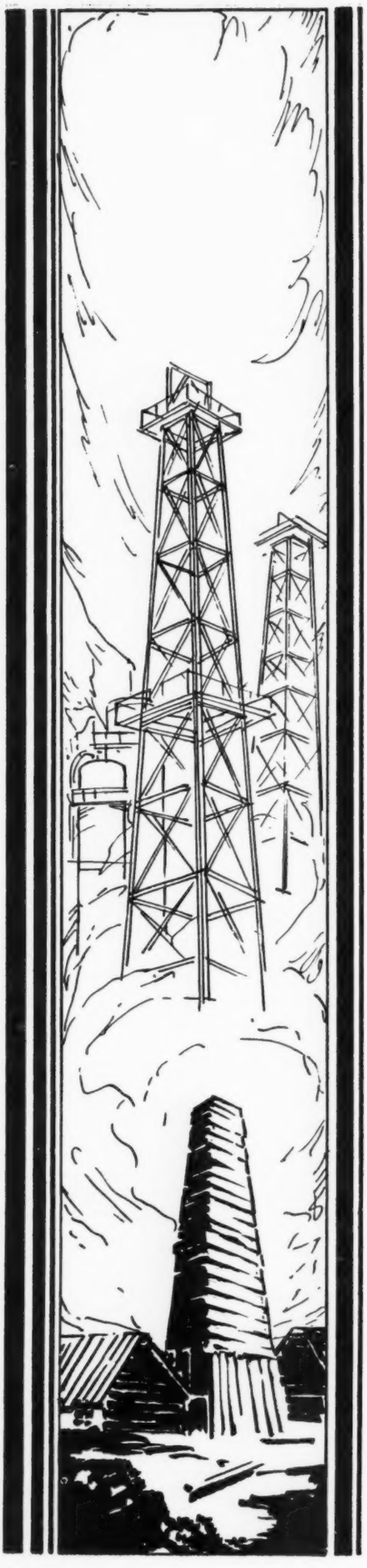
The crude helium is taken from the gas holder, compressed to about 2,000 pounds per square inch in a four-stage machine, carefully dried, and sent through a separation cycle similar to the one already described. This step increases the purity of the helium to slightly over 98 per cent. Since the purification unit handles only a small percentage of the total volume of natural gas processed, it is small in comparison with the separation apparatus. The auxiliary refrigeration cycle for the latter also makes up heat losses from the purification cycle. From the purification unit the helium, of about 98 per cent purity and still under high pressure, is delivered to tank cars, small cylinders, or storage.



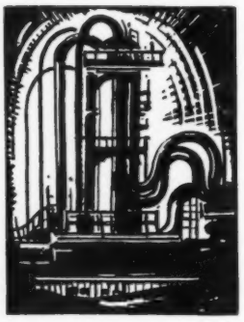
Power House—Left: Gas-engine driven three-stage compressors operating on the auxiliary refrigeration cycle. Right: Motor-driven four-stage compressors working on the purification cycle.

Helium is shipped from the Bureau of Mines plant to the Army and Navy flying fields in tank cars and small cylinders. The former consist of three or more heavy-walled seamless steel tubes mounted on railroad trucks. These tank cars hold approximately 200,000 cubic feet of free helium when the gas is compressed to 2,000 pounds per square inch. The small cylinders are filled to 1,800 pounds per square inch pressure and hold about 178 cubic feet each.

Prior to the World War, helium was considered a very rare gas and up to that time probably not over 100 cubic feet had been isolated.



The Spirit of the Pioneer . .



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Texas Ranks First in Petroleum Refining

By F. R. STALEY

MORE crude oil is refined and more gasoline is produced in Texas than in any other state in the Union. About 25 per cent of the 431,510,000 barrels[1] of gasoline made in the United States during 1931 was manufactured in this state. California ranked second, producing 16.3 per cent of the country's motor fuel. Texas refineries processed 24.2 per cent of the total crude charged to stills in the country last year.

The first refinery in Texas was built in 1898 at Corsicana by the J. S. Cullinan Company under the supervision of E. R. Brown, now president of the Magnolia Petroleum Company. Moreover, this was the first refinery ever built in the South. The refining units consisted of shell stills and batch agitators, and the plant was regarded as a model for efficiency at that time.

The use of fuel oil in locomotives was first tried in 1898 by J. S. Cullinan near Corsicana. He also pioneered in the use of oil on roads and streets. The development of the Spindletop field stimulated the use of fuel oil in the United States. The Texas Company produced the first fuel oil for naval use.

Today Texas leads the states in the number of refineries. The first day of this year there were 123 plants in the state; about 85 of which were operating. The total charging capacities of the plants is 935,000 barrels daily. This is 23.2 per cent of the country's total, exceeded only by the slightly greater capacity of California refineries.

Eighteen new refineries were constructed in the East Texas field last year. The total capacity of plants in this field is 72,500 barrels daily.

Large Capacity Refineries in Texas

Gulf Refining Company	Port Arthur	125,000 bbl.
Humble Oil & Refining Company	Baytown	125,000 bbl.
Magnolia Petroleum Company	Beaumont	70,000 bbl.
The Texas Company	Port Arthur	60,000 bbl.
Sinclair Refining Company	Houston	31,000 bbl.
The Pure Oil Company	Nederland	30,000 bbl.
Shell Petroleum Corporation	Houston	26,000 bbl.
Phillips Petroleum Company	Borger	25,000 bbl.
The Texas Company	Houston	20,000 bbl.
The Texas Company	Port Neches	20,000 bbl.
The Texas Company	Dallas	16,000 bbl.

[1]U. S. Bureau of Mines Information Circular 6641.

Two of the world's largest refineries are located on the Texas Gulf Coast, at Port Arthur and at Baytown, owned by the Gulf and Humble, respectively. These plants process a great variety of crudes and manufacture many kinds of petroleum products. A network of pipe lines supply them with crude, and their finished products are shipped to all parts of the world.

Texas refineries are not concentrated in any one part of the state, but are distributed from the Panhandle to the Gulf Coast. Although many types of plants are operated in Texas, most of them are the skimming type. Due to the great variety of crudes produced in the state many refining processes are used, and the problems involved depend, of course, upon the crude and the type of products manufactured.

Cracking Units

Texas refineries rank far ahead of those in any other state in cracking plant capacities. The larger refineries on the Gulf Coast have the greatest cracking facilities. The state contains about 26 per cent of the country's potential rated charging capacity. In recent years the tendency has been toward larger units.

Many kinds of cracking processes are used in the various refineries, but most of the capacity is confined to four or five types of units operated in the large refineries. The Humble Oil & Refining Company has the largest cracking installation at Baytown, consisting of tube-and-tank units. The Texas Company ranks second, using Holmes-Manley, de Florez, and Pressure-coke units. The Gulf Refining Company uses its own type of unit. The Magnolia Petroleum Company uses Cross units; their largest installation being at Beaumont. The Sinclair Refining Company uses Isom units; and the Shell Petroleum Corporation uses Dubbs. Both of these refineries are near Houston. The Pure Oil Company has a Gyro installation at Nederland. Large quantities of petroleum coke are produced by the Texas refineries. In many plants asphalt crudes are reduced to coke, much of which is used as refinery fuel. According to the Bureau of Mines figures, 280,000 tons of petroleum coke was used as refinery fuel in 1930 in the Texas Gulf Coast district.

Texas Pacific Coal & Oil Company Fort Worth Refinery

Fuel Consumption

The refineries in inland Texas, or in Texas exclusive of the Gulf Coast, increased their crude runs from 58,313,000 barrels in 1929 to 60,400,000 barrels in 1930,[2] and their fuel consumption from 19,479 billion B.t.u. in 1929 to 24,718 billion B.t.u. in 1930. The average B.t.u. requirement per barrel of crude refined increased from 334,000 in 1929 to 409,000 in 1930. This material increase was due to the operations of the West Texas group of refineries. In comparison with the fuel consumption in 1929, this group doubled its consumption of oil, showed a small decline in the use of natural gas, and a material increase in the consumption of refinery gas.

The refineries in the Texas Gulf Coast area utilized 135,939 billion B.t.u. in 1930, which was the largest amount of heat utilized by any district during that period. The total crude oil processed in the district in 1930 amounted to 154,912,000 barrels, hence the average heat requirement per barrel was 878,000 B.t.u. This represents a small increase in average heat required over the previous year.

In 1930 the refineries in the Texas Gulf Coast area showed a decline in the consumption of fuel oil and an increase in the consumption of refinery gas. Their consumption of natural gas is available from near-by fields but the extensive cracking operations produce large quantities of refinery gas and heavy residuum. The district is the largest producer of petroleum coke.

Major Cracking Plant Installations*

Company	*Location*	*Units*	*Daily*	*Type*
Humble Oil & Ref. Co.	Baytown	20	143,000	Tube & Tank
Gulf Refining Co. -	Port Arthur	47	68,000	Gulf
Magnolia - - - -	Beaumont	20	55,000	Cross
Shell Petroleum Co. -	Houston	6	12,000	Dubbs
Sinclair Refining Co. -	Houston	23	30,000	Isom
The Texas Co. - - -	Port Arthur	38	80,000	Holmes-M'ly

*Bureau of Mines, I. C. 6509, January 1, 1931.

During 1931 there was considerable expansion in cracking plants. The Bureau of Mines reports that there is an indication of a net decrease in the number of refineries which have cracking equipment, but there was an increase of 5 per cent in the total charging capacity in the country during 1931.

Only a small number of refineries in Texas manufacture lubricating oils. Most of the plants are the skimming or skimming and cracking variety. Many plants skim the crude and then run the reduced crude to coke in coking stills, using the distillate from these stills as charging stock for the cracking units. Due to the lighter charging stock the running time is greatly increased. Many of the smaller plants do not operate cracking units, and must sell the reduced crude for fuel or for road oil. Residuum from crudes containing paraffin are high in pour point, and it is often difficult to find a market for it.

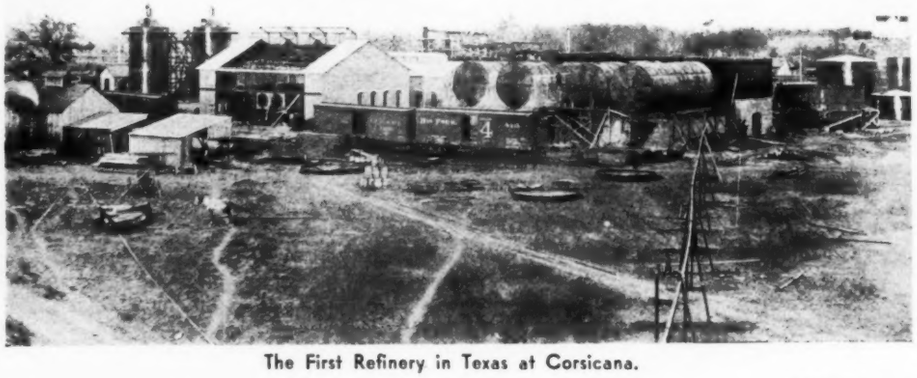
Many of the West Texas and Panhandle crudes present difficult refining problems, due to the presence of hydrogen sulphide and small amounts of emulsified brines. Unless measures are taken to combat corrosion and erosion the refining and storage equipment is rapidly deteriorated. In addition to the corrosive effect of hydrogen sulphide the magnesium and calcium chlorides from the brine are decomposed at elevated temperatures forming hydrogen chloride and in the presence of moisture hydrochloric acid, which is very destructive to most metals. By the use of special materials of construction and neutralizing chemicals refining corrosion has been greatly reduced, but many problems yet exist.

Since most of the crudes containing lubricating fractions are either mixed base or naphthenic, it is necessary to distill and fractionate the viscous portions under vacuum before they can be further refined. Very few of the paraffin crudes can be reduced and the residue acid treated to produce lubricating stocks. In some plants wax distillate cuts are made on the crude by distilling with fire and steam under atmospheric pressure.

[2]U. S. Bureau of Mines R. I. 3145.

Representative Texas Crudes

Field	*Gravity A.P.I.*	*Viscosity Saybolt*	*Pour Point*	*Sulphur %*	*Gasoline and Naphtha*	*Base*
Barbers Hill	33.4	44/100F	Below 0F	0.67	31.0%	Naphthene
Big Lake	37.5	51/70		.40	32.2%	Mixed
Burkburnett	36.8	38/100	Below 0F	.40	36.7%	Mixed
Conroe	38.0	32/100	30	.10	39.2%	Mixed
Kilgore	40.0	40/100	25	.29	36.0%	Mixed
Lathrop	38.4	41/100	30	.26	35.0%	Mixed
Mirando	21.8	70/100	Below 0F	.28		Naphthene
Panhandle	36.6	54/100	50	1.10	26.5%	Mixed
Ranger	38.0	40/100	Below 0F	.17	30.2%	Paraffin
Van	33.4	56/100	Below 0F	.89	24.6%	Paraffin
Winkler	29.0	55/122	Below 0F	1.53	22.5%	Mixed
Yates	29.6	55/122	Below 0F	1.58	23.6%	Mixed



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In 1927 the Texas Pacific Coal and Oil Company at Fort Worth made the first paraffin base zero pour test bright stocks commercially from Ranger crude. Centrifuges were used to dewax the oil. It was filtered by the pulp process of contact filteration.

The process consisted in reducing Ranger crude by fire and steam distillation to the required flash point. The reduced crude was then treated with concentrated sulphuric acid. The sludge was drawn off, and the pepper centrifuged out. The acid oil was then simultaneously neutralized and decolorized by the clay pulp which was mixed with the oil and circulated through a pipe still heated to an optimum temperature. The clay was filtered out after dilution with naphtha. The filtered oil in naphtha solution was chilled to a sub-zero temperature at a definite rate of cooling and then dewaxed in centrifuge machines. The dewaxed solution was run through a pipe still to distill off the naphtha and reduced to specification viscosity. The stock was brightened in a vacuum column and any trace of fine clay removed by straining through a shallow layer of coarse clay. By careful control and low chilling temperature practically all of the wax was removed from the oil.

In recent years the use of a hydrocarbon material known as paraflow is generally used in motor oils to produce a zero pour test oil. This is less expensive than removing the last trace of wax, which requires a very low chilling temperature. This material acts as an inhibitor to prevent wax crystallization.

Contact filtration is generally used in Texas refineries for filtering lubricating oils since the oil is both filtered and neutralized by the clay. In most cases the clay is used in the dry form rather than as a pulp. Frequently treated clays are used. Texas produces many clays that are satisfactory for refinery use. A number of refineries own their own deposits and clay treating plants. Clays suitable for Gray vapor phase towers are all produced in the state. A number of the crudes produce straight run or cracked gasoline that is exceptionally high in octane rating, among these being Mirando and Winkler crudes. A number of very deep wells in the Big Lake field are producing a very high gravity crude; about 56 A.P.I. The producing sands are exceptionally thick and there is evidently an extensive reservoir of this oil.

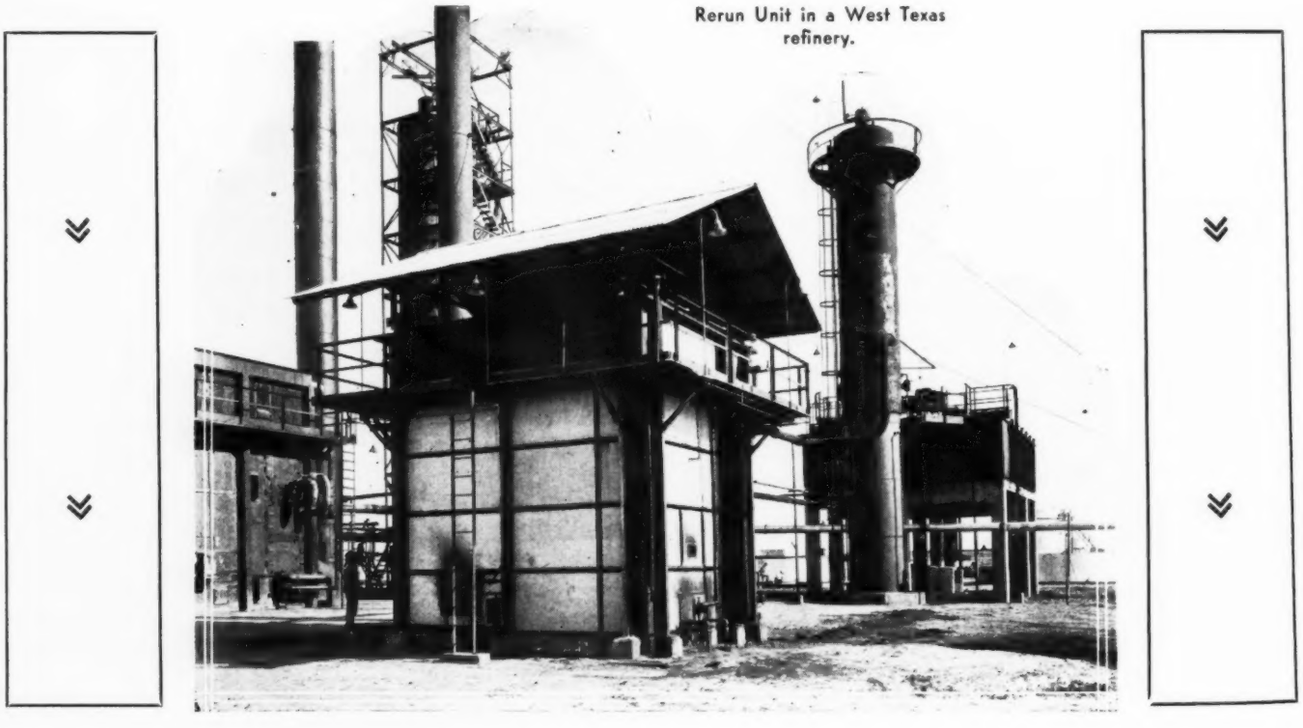
At the present time the East Texas field is the largest producer of crude. According to the Bureau of Mines investigation sample from the Joiner, Kilgore, and Longview fields all have the same general characteristics, each containing a low percentage of sulphur. The total gasoline and naphtha average 36 per cent, the kerosene distillate 9.6 per cent, the gas oil 15.1 per cent, the non-viscous lubricating distillate 9.7 per cent, and the medium lubricating distillate 6.2 per cent. The gas oil appears to be a good stock for the production of gasoline by cracking processes, and the lubricating distillates appear to be similar to distillates of the same ranges of viscosity obtained from Burbank, Okla., crude, which is generally recognized as a high-grade refining crude.

Crude from the Van field of Texas differs in several respects from the East Texas crudes. The gravity (33.4 deg. A.P.I.) is heavier, the sulphur content (0.89 per cent) is greater, and the "total gasoline and naphtha" fraction is only about two-thirds that of the East Texas crudes. Moreover, the crude is placed in the "paraffin base" class according to the United States Bureau of Mines method of analysis and interpretation.

Many of the larger refining companies maintain extensive research laboratories to study refining problems and to improve or develop new products.

Refineries processing lubricating oils usually manufacture greases and other petroleum specialties. There are a number of very large grease plants in the state which produce complete lines of lubricants for automobile, airplane, railroad and marine equipment.

The value of the refined petroleum products of Texas represents about one-third of the total value of all products manufactured in the state. No other industry even approaches this figure.



Rerun Unit in a West Texas refinery.

Texas Panhandle in the Oil and Gas Industry

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Texas Panhandle

THE Panhandle district, which embraces the northern portion of the Permian Basin of Texas as well as a considerable part of the western portion of the Anadarko Basin of Oklahoma, first attracted nation-wide attention for its oil producing fields in the year 1926, when 683 wells were completed with only 30 dry holes. These wells raised the oil production of the region from a total daily production of 2,100 barrels in January to an average daily production for the month of December of 159,190 barrels.

Early development of the oil industry was slow in the Panhandle, however, because of the inaccessibility of the region, which made it dif-

(*Continued on page* 121)

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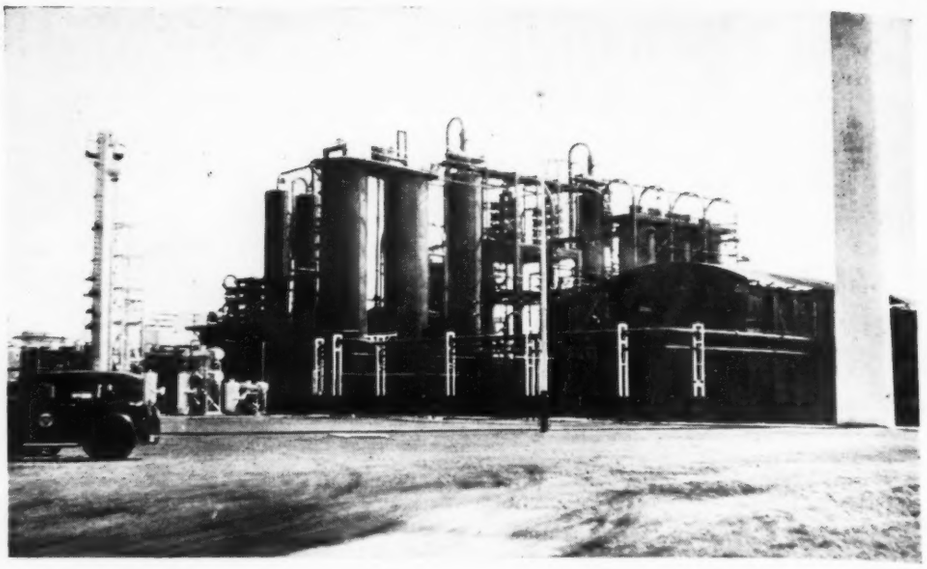
Continental's Wichita Falls Refinery



IN keeping with the company's policy, the Continental Oil Company's refinery at Wichita Falls, Texas, is remarkable for its neat and well-kept appearance which characterizes safe and efficient operation. It is one of the most attractive industrial plants in this part of the country. A well-designed flood lighting system illuminates each unit at night so that operations can be carried on as effectively as during the daylight hours. All of the equipment in the plant is kept painted, and the interiors of the various buildings are always very clean.

The company operates eleven modern refineries which are located in the Mid-continent, Rocky Mountain and Eastern Seaboard areas. Conoco products are marketed throughout the United States, and its patented Germ Process motor oils are popular with a great many motorists. The major portion of the products made in the Wichita Falls refinery are marketed in Texas.

North Texas crudes are processed at this refinery, which has a charging capacity of 6,000 barrels of crude oil per day. It is a combination skimming and cracking plant, operating under Cross patents. The unit has two furnaces, one of which is used in the skimming operation, and the second contains the high pressure cracking coils. The waste heat from the cracking operation is used for skimming the light fractions from the crude. The products are gasoline, kerosene, and fuel oil.

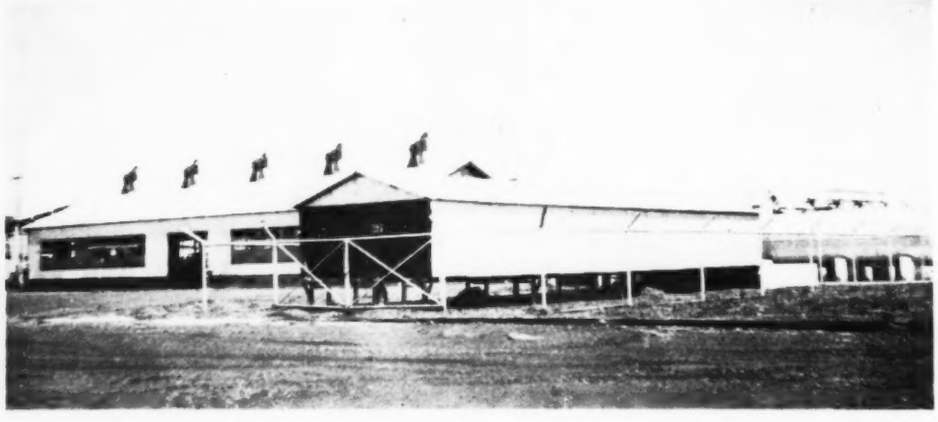
The hot oil pump installation for the cracking operation is very interesting. It consists of three National Transit duplex pumps, each driven by a two-stage Corliss steam engine operated condensing. Only two of the pumps are operated at a time, the third is a spare. This type of pump affords reliability, flexibility, and the safety of steam power. A uniform flow of hot oil is assured. When one plunger is near the end of its stroke, the plunger on the opposite side is at the center of its stroke and is traveling at his highest speed. Thus, both the speed and pressure of the oil in the common discharge line are kept constant.

The installation of recording and control instruments for the skimming and cracking unit is exceptionally large. All of the important temperatures of the furnace, vapors and oil are either recorded or automatically controled with Brown instruments. They maintain a uniform and efficient operation of the unit at all times.

The unit is equipped with two Gray towers in which the cracked gasoline is treated in the vapor phase. These towers are operated in series, and an after-bubble tower is installed to remove all traces of polymers. A stable gum-free gasoline is produced without the use of acid, and without any loss in octane rating. The Continental Oil Company has Gray tower installations at its refineries in Artesia, N. M.; Denver, Colo.; Ponca City, Okla.; Sapulpa, Okla.; besides this plant. The Gray Vapor Phase Process is used extensively in the refining industry for treating cracked gasolines.

The gasoline is sweetened in a closed continuous system consisting of towers and settling tanks. The kerosene is treated in batch agitators. All treating is carefully controlled by the laboratory. A testing laboratory is maintained at the plant to check refining processes and to test all finished products. Conoco Ethyl Gasoline is blended at the plant. The Ethyl fluid for this plant is received in cylinders. A special building, fenced off from the rest of the plant is used to store the fluid.

The gases from the cracking unit are processed in a vapor recovery compresion plant. All of the cracked gasoline is stabilized in a modern unit. Gasoline shipped from any of the Continental refineries is practically propane free, which eliminates any vapor locking trouble in service. The residue gas, which is very high in calorific value, is used as refinery fuel.



Steam required for the refinery is generated by two 350-horse power Heine water-tube boilers. One of these operating at 150 per cent of rating meets the entire demand of the plant. The boiler feed water is obtained from wells. A hot lime soda treatment is used with sodium aluminate as a coagulant. The water for the plant is obtained from the irrigation system.

Wichita Falls in the Oil Industry

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Oil and Wichita Falls

By WILBURN PAGE

Since Wichita Falls and oil have been synonymous in the eyes of the outside world since the great Fowler strike of 1918 and the ensuing boom which lasted through 1920, it is often a surprise to many to learn that oil played a very definite part in the industrial growth of this modern West Texas city from 1901 to the present day.

It was in 1901 that a Clay County farmer, seeking a new water supply, disgustedly struck oil at a depth of 225 feet. There being no market for the product at that time the farmer and his neighbors soon learned to use it as an insecticide and as a lubricant for their farming tools. Right on the heels of this first discovery oil was again found in a drill for water on the Waggoner ranch on the present site of the city of Electra, this time at the remarkably shallow depth of 220 feet. These wells called for more drilling and as a market for the commodity developed hundreds of shallow wells were sunk to give this section a good output for the next decade.

On April 1, 1911, this territory experienced its first real taste of an oil boom when what many thought to be an April fool joke turned out to be a real gusher and the largest well brought in up to that time. An overnight mushroom growth filled the cities close to the production and gave to Wichita Falls a wave of high prosperity which lasted until 1915, when overproduction and resultant low prices led many operators to leave, believing that this section as a productive money field had exhausted itself.

For the next few years only a few new tracts were opened and interest in the industry was more or less at a standstill which meant that an unsuspecting citizenry was unprepared

(*Continued on page 122*)

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Southwest Texas

THE Southwest Texas oil-producing area consists of four distinct districts, and is characterized by a wide diversity of conditions. The districts are: the Fault Line, which has furnished several of the largest fields and is still undergoing important development; Southwest Coastal Region, which became an important producing territory in 1929 with the discovery of the Refugio and Pettus fields; the Laredo District, which was so long an isolated oil-producing province that it was formerly, although incorrectly, not considered a part of the general region; and the Edwards Plateau, a hilly country considered important prospective oil-producing territory.

Southwest Texas is one of the newer sections of Texas in point of large oil development production. As late as 1920 its entire annual production was far under one-half million barrels, a figure that was raised to 34,770,335 barrels during the year 1931 with several fields heavily prorated.

Gas fields had been producing in Southwest Texas as early as 1911, but the first oil production of any consequence was the discovery of the Thrall field in 1915, followed by the Somerset field in 1918 and the Laredo district opening in

(*Continued on page* 122)

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Repressuring Practice in Texas

By K. C. SCLATER

ALL oil field operations involving the injection of gas or air into oil sands to maintain or increase the rock pressure for the specific purpose of increasing the ultimate recovery of oil from a pool come under the head of the general term 'Repressuring.' When the gas is injected into the producing sand during the flush stage of production or in the early life of a pool in such manner as to retard the rate of decline of rock pressure the more specific term given to the repressuring operation is 'Pressure Maintenance.'

Repressuring on a small commercial scale, with air as the repressuring medium, was first used about twenty years ago in an old depleted shallow field in southeastern Ohio. It was then known as the Smith-Dunn (the names of the two originators of the process) or the Marietta process. Early progress in the application of the process was slow. Aside from the limitations arising from the lack of suitable equipment and appliances, inherent sub-surface difficulties were encountered. These were hard to overcome owing to a woeful lack of knowledge regarding underground conditions. Gradually, however, as the possibilities of the process became more evident, its use began to spread concurrently, skill and technique in applying the process in the field improved. When the important part played by natural gas and gas energy in the production of oil came to be generally recognized several years ago, repressuring quickly sprung into prominence; its use from then on increased rapidly and soon became widespread. Today, as a process in the economical production of oil, it occupies a highly important place.

Some of the most successful repressuring projects in the world today are in Texas. Three in particular, Cook Ranch, Sugarland and Raccoon Bend, are well known as pioneer projects of their kind and each is of especial interest because of the advanced practices that are in use.

All three are repressuring projects of the pressure-maintenance type. Only in this particular are they similar.

The Cook pool is in Shackelford County, Texas, and, save for a small strip on the southern edge and another on the northwest edge of the pool, the entire producing acreage is held under lease by Roeser & Pendleton, Inc. and the Continental Oil Company. Fortunately, the two other operators owning the strips on the edge co-operate fully in the repressuring project so that the pool virtually is operated as a unit. The Cook sand from which most of the production is obtained lies at an average depth of 1300 feet. It varies in thickness from five to thirty feet and has an estimated porosity of approximately thirty per cent.

From February, 1926, when the discovery well was completed, until May, 1927, when 142 wells were producing 8,700 barrels of oil and 7,000,000 cubic feet of gas daily, preliminary tests on wells by means of a portable compressors gave results that were sufficiently favorable to warrant a repressuring project for the pool.

Compression equipment for repressuring service is installed in the casinghead gasoline plant and consists of three 190-H.P. direct driven gas-engine two-stage compressors, capable of delivering 4,000,000 cubic feet of gas daily at a pressure of 400 pounds per square inch. Residue gas and fractionator vapors are obtained from the gasoline plant at 30 pounds pressure.

Key wells for the injection of gas are each equipped with an automatic volume controller and a string of tubing open at the bottom and packed off at the casinghead.

Provision is made for testing the daily gas and oil production of each well at least twice a month by having at each battery of lease tanks a test trap and a test tank with pipe manifold into which the well flow lines are connected.

At the key wells the daily volume of gas injected per well varies from 25,000 to 300,000 cubic feet. At least once a month a rock-pressure reading is taken at each injection well simply by shutting off the supply of injected gas and noting by recording gauge the pressure to which the gas in the well drops and becomes constant.

Originally, wells for injection were chosen from wells producing on the higher parts of the structure. It was found, however, that structural position had little to do with the suitability of location of a key well so low is the dip, about 50 feet to the mile, and so variable the sand conditions. Permeability of the sand became the governing factor in the choice of an injection well after much trouble from by-passing of gas in the sand when using the original injection wells. Eventually, wells that produced small amounts of oil, and believed to have a 'tight' sand or where the sand in the vicinity of the well had a low permeability, were chosen as injection wells, for it was found they cut down by-passing of the gas in the sand. Partial evidence of a wide variation in the permeability of the producing sand over the field was observed in the great differences of pressure required to inject the required volume of gas at different key wells. In some wells the high resistance to the injection of gas was caused by a clogged sand condition, a remedy for which was the washing of the face of the sand with steam and hot water delivered down the tubing.

Many operating troubles at key wells were overcome in this field the first year or two after the repressuring program was put into effect. Freezing troubles in winter caused by water vapor in the distribution lines were prevalent and has been practically overcome by installing an after cooler and scrubbing equipment through which the gas passes after the high-stage compression and before it is delivered to the key wells. Freezing of the automatic controllers for regulating the volume of injected gas to the key well was another source of trouble in winter and was successfully eliminated by the installation of a heater on the upstream side of the volume control valve at each well.

Building up of the injection pressure on key wells was a frequent source of trouble, making it necessary to wash the face of the sand in the affected key well with steam and hot water at periodic intervals. It was found on investigation that the cause of this trouble was a gradual accumulation of particles of rust on the face of the sand in the key well. The source of the rust, the inner walls of the gas distribution lines in the field, suggested a remedy for the trouble. At each injection well a filter inserted in the injection gas line to catch the rust has eliminated the trouble.

Most of the wells in the field are produced by pumping. One of the essentials in the success of a repressuring project of this kind is that the wells be produced with a low gas-oil ratio. In this field, the problem of maintaining production of oil with a low gas-oil ratio was a difficult one. Its solution required a considerable amount of field investigation into the pumping characteristics of the wells. Many methods of pressure control were tried before a satisfactory gas-oil ratio was obtained. Part time pumping was tried but due to the fluctuations in the fluid level of the well caused thereby, it was not practicable to hold the gas-oil ratio within a range close enough for requirements. Special gas anchors were also tried but with

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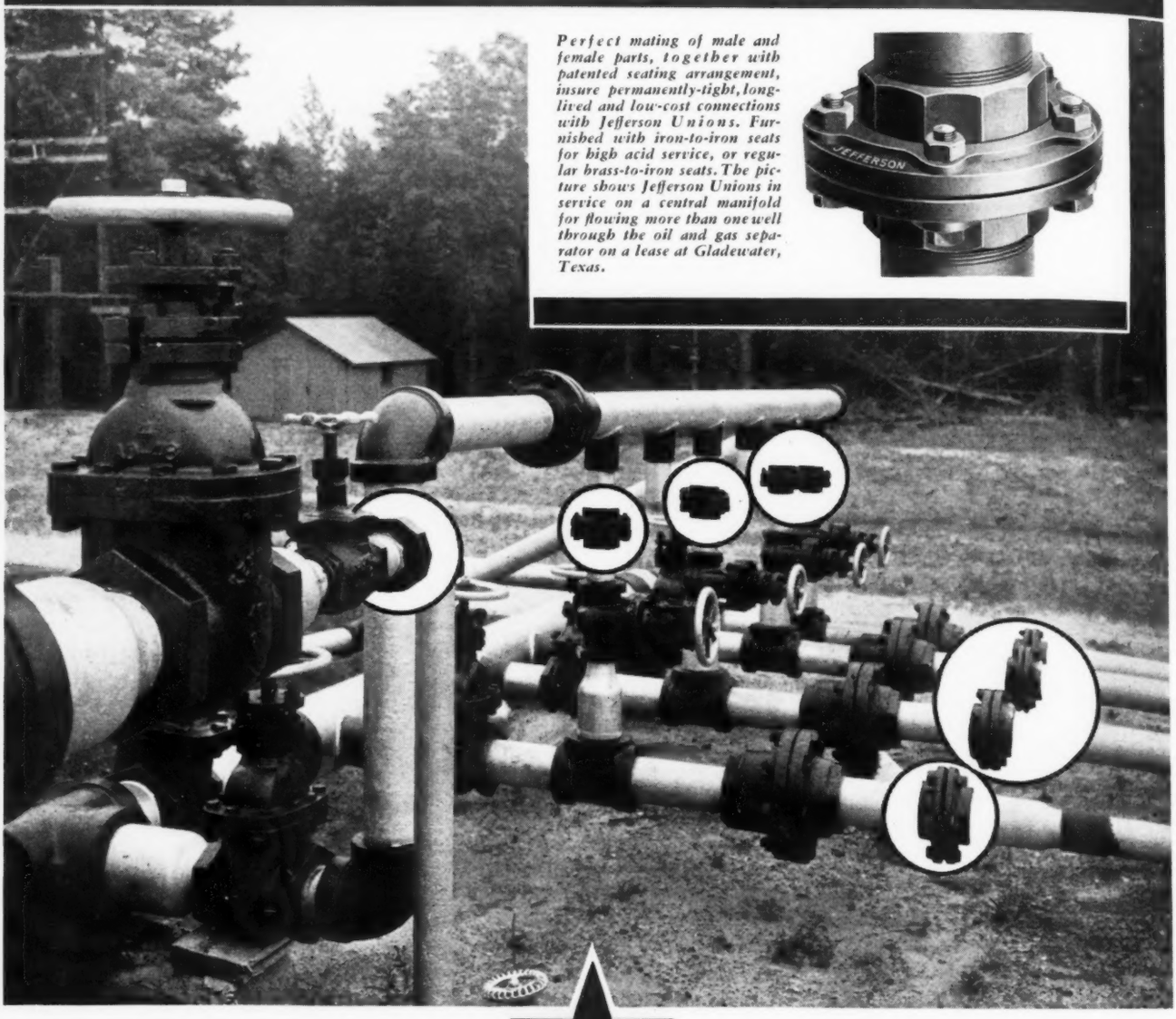

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indifferent results that were not wholly satisfactory. Changing the pumping depth by raising or lowering of the working barrel was only partially successful and far from satisfactory.

It was found that wells were quite sensitive to changes of back-pressure and that holding the fluid level steady gave the most feasible method of controlling the gas-oil ratio within the required range. Of the many methods to accomplish this that were tried the most practical and economical was that of varying the length of the pumping stroke. By means of a special swing post on the pumping jack the length of pumping stroke can be adjusted to within an inch. Holes at one-inch intervals in the swing post make this possible and the change can be made in a few minutes by the pumper.

Before proration regulations were applied a typical well in the field had an average daily production of fifteen barrels of oil and a gas-oil ratio of 1000 cubic feet per barrel. The average gravity of the oil is 39 degrees A. P. I.

Up until the latter part of 1929, when proration was put into effect, the average volume of gas returned to the sand was seventy per cent of the total volume of gas produced with the oil. Since proration has been in force, the percentage of gas returned has increased. The gasoline content of the gas produced has averaged from two to three gallons per thousand cubic feet.

Proration restrictions in this field, as in many others, have had the net effect of retarding still further the rate of decline of rock pressure.

Remarkable results have been obtained in this field through repressuring. It is estimated that by repressuring this field the ultimate recovery of oil has been increased from five and one-half to fifteen million barrels. Methods in this field have been discussed in some detail, as the field is one of the best-known examples that illustrate the possibilities of pressure-maintenance in the early life of a field where the conditions are favorable, and where the most modern practices are followed.

Sugarland field, Fort Bend County, where a pressure-maintenance program is being carried on with remarkable success, has the distinction of being a salt-dome field and for this reason holds more than ordinary interest as a repressuring operation. The dome is of the deep-seated type and the depth of the top of the producing horizon is from 3,100 feet to 3,700 feet.

The entire productive acreage is held under lease by the Humble Oil Company, hence the field is operated as a unit. Much accurate information has been gathered on the underground conditions and to this fact can be attributed a large part of the success of the repressuring project.

The producing horizon, composed of oil sands interbedded with sandy shale, is from 100 to 300 feet thick and forms a persistent layer overlaying the salt dome.

The discovery well in the field was put on production in March, 1928, and the original rock pressure, as estimated from pressure reading on wells drilled later was 1,475 pounds per square inch.

In the late summer of 1929 an engineering study was begun to determine the feasibility of returning gas to the sand while the rock pressure was still high. Enough data of a conclusive character were gathered that favored consideration of a repressuring project for the field. Definite information on the rate at which the gas could be injected and the pressure required was not available, so early in 1930 field tests were made with portable high-pressure equipment capable of delivering 900,000 cubic feet of gas daily at a pressure of 2,000 pounds per square inch with an inlet pressure of 400 pounds per square inch. These preliminary studies were comprehensive in the range of operating conditions considered and anticipated. The relative advantages of single-trapping and double-trapping of gas were investigated in detail and definite conclusions made before the work of planning the details of the equipment at the wells and the repressuring plant was begun.

Plans were finally completed for the construction of a repressuring plant capable of handling a daily volume of 16,000,000 cubic feet of gas. This volume was based on a daily production of 25,000 barrels of oil and an estimated average gas-oil ratio of 640 cubic feet per barrel.

Conservation of gas was the paramount consideration so that as high a percentage as possible of the gas produced could be returned to the sand.

On April 1, 1930, the plant was put into operation. Provision was made for almost every contingency and the plant and well equipment are considered the most modern and complete of their kind.

Compressor equipment consists of six 100-H.P. low-stage units with 8½-inch compressors each having a capacity of 740,000 cubic feet daily at thirty pounds inlet and 400 pounds per square inch discharge pressure, and four 100-H.P. high-stage units with 4½-inch by 20-inch compressors each having a capacity of 1,200,000 cubic feet daily at 400 pounds inlet and 2,000 pounds per square inch discharge pressure.

The average injection pressure at the key wells was 1,350 pounds per square inch, and the average volume of injected gas per well was 1,250,000 feet daily. With proration restrictions the present volumes are lower but there have been only slight changes in injection pressures.

Wells are equipped with 2-inch and 2½-inch tubing, which is run to within a few feet of bottom. Each well has an individual gas trap; a meter for gas measurement and a pressure gauge on the tubing and on the casing. Oil from each well is run to separate lease tanks so that an individual daily gauge of oil production is obtained. Wells on a small area on the crest of the dome produced with high gas-oil ratios. By controlling the flowing pressure with an adjustable flow bean the optimum flowing condition for gas-oil ratio was obtained. Those wells having high gas-oil ratios were chosen as key wells, and of the remainder, those having an excessive gas-oil ratio were closed in and production made up from other wells on the lease.

As an agreement was reached early in 1929 whereby the oil production from the field was to be held to 12,000 barrels daily, it meant that as new wells were put on production, those with high gas-oil ratios were closed in and the production from other wells reduced by adjustment of the bean.

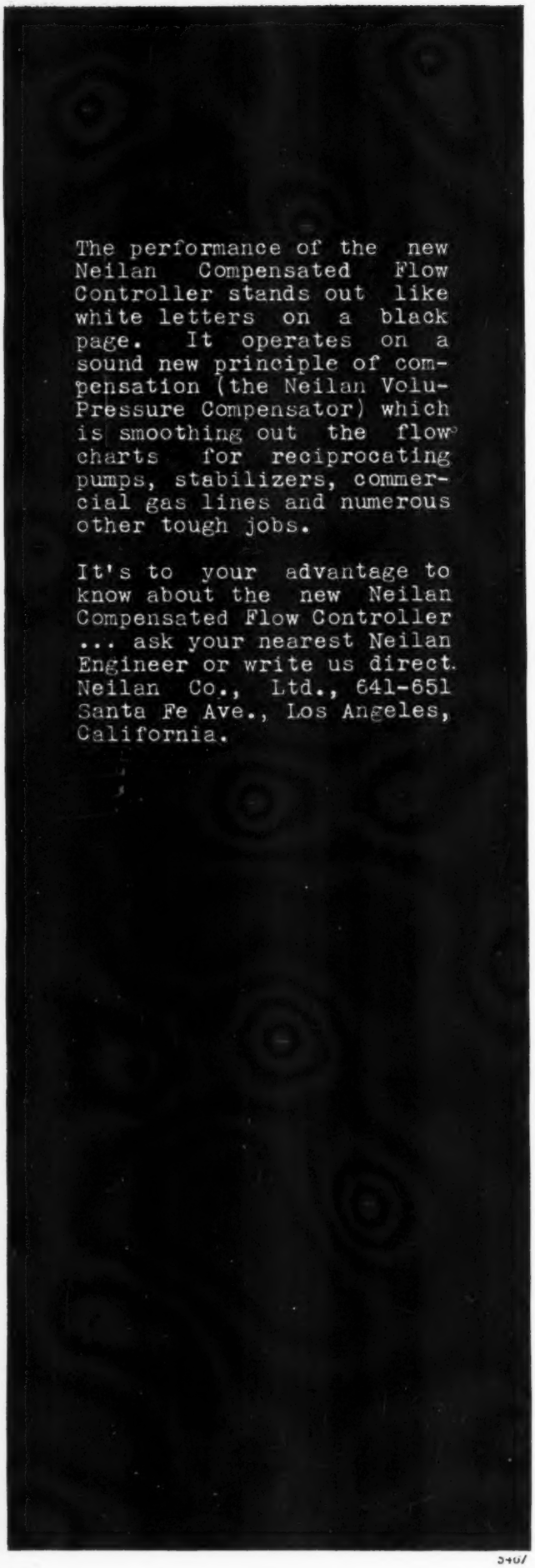
In this manner the average gas-oil ratio for the field was gradually reduced until in March, 1930, the reported gas-oil ratio was 265 cubic feet per barrel. This is an extremely low gas-oil ratio for a field of this type.

An average pressure of fifty pounds per square inch is carried on the traps, whence it is returned to the compressor plant and recompressed to 1,350 pounds or higher.

There are four injection wells, all which are located on top of the dome and penetrate the free gas zone. The average injection pressure now is from 1,350 to 1,400 pounds per square inch.

Experience indicates that in this field it is preferable to inject the gas through wells on top of the structure rather than through wells on the flank. An injection well down dip was found to have increased the gas-oil ratio of near-by wells up dip. No such effect on gas-oil ratios has been observed when the gas injection well is in the free gas zone. This experience indicates that in this field at least, there is a tendency for the gas to by-pass when it travels up dip.

Although the field has been producing for two and one-half years, the results from a number of bottom-hole pressure tests made on twenty-eight out of the thirty-seven wells flowing at the end of this period indicated an average rock pressure of 1,400 pounds. This is a total pressure drop of only about seventy-five pounds when compared with the original rock pressure, or an average pressure drop of 2½ pounds per month. A total of seven million barrels of oil had been produced during this two and a half year period.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Engineers of the Humble Oil Company have shown that had the field been produced by ordinary methods without returning the gas to the sand the average gas-oil ratio for the field would probably have been 1,000 cubic feet per barrel and the rock pressure 350 or 400 pounds. As a result the total ultimate recovery from the field, it is estimated would be only a fraction of that produced to date.

With about 90 per cent of the gas being returned to the sand the actual gas-oil ratio is the difference between the volume of gas produced with the oil from the sand and volume of gas returned to the sand by injection. This is now about thirty cubic feet per barrel. Against this low gas-oil ratio is only the expense of the handling of the gas, compressing it and returning it to the sand. The actual cost of compression of the gas is said not to exceed eight cents per thousand cubic feet. The net amount of gas handled by the plan is about 230 feet per barrel of oil produced; so the cost of returning the gas does not exceed two cents per barrel.

It is significant that repressuring has been applied so successfully to a salt-dome field as deep as that at Sugarland. In the average field of this type only a small quantity of production is recovered by flowing and occasionally water encroaches rapidly to trap the oil before or usually after the well is pumping, thus adding greatly to the lifting cost. By returning the gas as has been done at Sugarland and maintaining the rock pressure at or near the original pressure, water encroachment is virtually arrested. It is realized, of course, that the sand conditions in salt-dome fields are usually irregular and not so conducive to repressuring as they are at Sugarland. However, it is certain that many salt-dome fields could have been made to produce more uniformly and over a much longer period with a consequent increase in ultimate recovery and with lower lifting costs had repressuring been resorted to in its early life.

Another prominent repressuring operation is the Raccoon Bend field in Austin County. This field was discovered in 1927 when oil was found in the Humble Oil Company's well, Thompson No. 2, which was completed at a depth of 1,007 feet with an initial production of thirty-five barrels of oil of seventeen degrees gravity A. P. I.

This field, like Sugarland, is entirely controlled and operated by the Humble Oil and Refining Company. Thoroughly alive to the possibilities of repressuring in salt-dome fields in their early life, this company in the spring of 1929 started to investigate the repressuring possibilities of the field.

There are two producing horizons; one a depth from 2,900 feet to 3,140 feet and the other at a depth from 3,250 feet to 3,400 feet.

When the field was being drilled gas from a shallow sand at 1,000 feet was used as fuel. To conserve this gas a small gasoline plant was installed by means of which the waste gas from oil producing operations could be utilized as fuel. Injection tests made on wells and other pertinent field data gathered, all favored a repressuring program. It was found that injection pressures from 400 to 1,300 pounds per square inch would be required.

A compression plant was soon constructed and was put into operation in July, 1930. It had a daily capacity of seven million cubic feet of gas. Wells added while the plant was under construction increased the gas volume of the field beyond the capacity of the plant. Close pressure control at the wells has now reduced the average gas-oil ratio prevalent then.

The present plant has a daily capacity of nine million cubic feet of gas. After being compressed from atmospheric pressure to thirty-five pounds it passes through intercoolers to remove the heat of compression. After passing through the coolers it is compressed from thirty-five pounds to 150 pounds per square inch, then passed through absorbers to extract the gasoline. After being denuded of its gasoline content the gas is further compressed, part of it to 300 pounds per square

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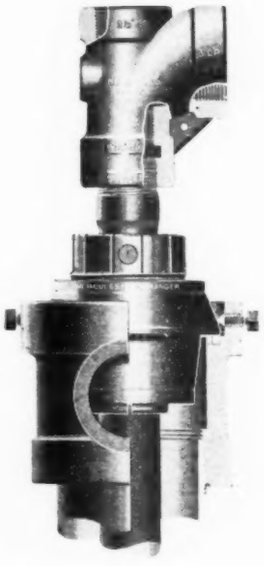

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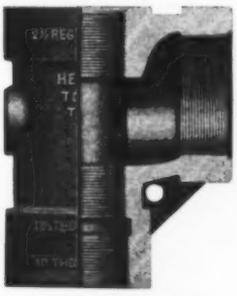

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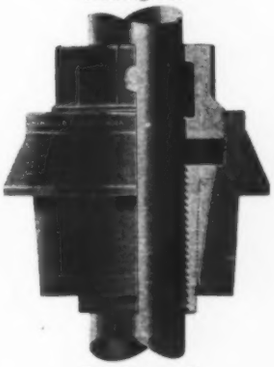

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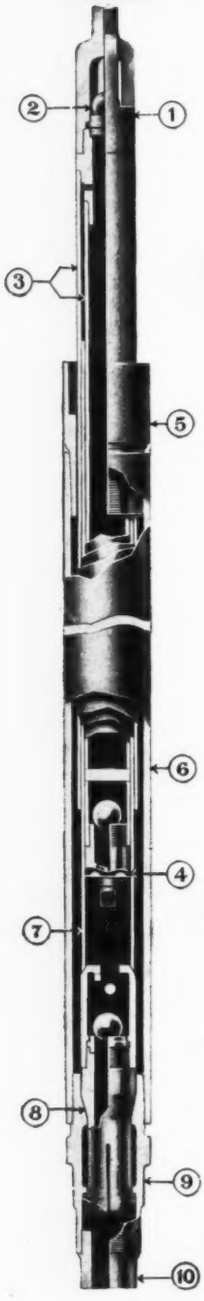

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inch for injection into the shallow zone and part of it to 500 pounds per square inch for injection into key wells not requiring higher pressures. The remainder of the gas is compressed from 150 to 1,000 pounds per square inch for injection into the higher pressure key wells.

Compressor equipment consists of ten units for the low-pressure system and eight units for the high-pressure system. The low-pressure system is made up of: one seventeen-inch by twenty-inch double acting single-stage compressor direct driven by 100-H.P. gas engine (this unit compresses the gas that is used for fuel at the plant from naught to thirty-five pounds pressure); five seventeen-inch by ten-inch by twenty-inch two-stage compressors in tandem direct driven by 100-H.P. gas engine (compresses gas from naught to thirty-five and from thirty-five to 150 pounds pressure); four seventeen-inch by ten-inch by twenty-inch double acting two-stage twin compressors direct driven by 200-H.P. twin gas engine (compresses gas from naught to thirty-five and thirty-five to 150 pounds pressure). All these low-stage compressors have a six-inch inlet and a four-inch discharge.

In the high pressure system are: one six-inch by twenty-inch double acting single-stage compressor direct driven by 100-H.P. gas engine (compresses gas from 150 to 500 pounds pressure); six six-inch by twenty-inch double acting single-stage compressors direct driven by 100-H.P. engine (compresses gas from 150 to 1,000 pounds pressure). All these have a four-inch inlet and a two-inch discharge; one special 100-H.P. gas-engine driven high-pressure unit with a four-inch by twenty-inch compressor for boosting the gas to pressures beyond 1,000 pounds and up to 2,000 pounds per square inch. This unit discharges into a special 1,250-pound pressure header from which the gas is delivered direct to the key wells in the field.

At this plant there is an elaborate system of inter-coolers and scrubbers for the gas. Also a system of headers for gas at the various pressures from which the gas is distributed to the key wells. Two-inch lines carry the compressed gas from the headers to the key wells. All headers are equipped with relief valves and regulators. There are nine headers in the system: three twenty-inch low-pressure headers; two sixteen-inch 150-pound headers; four four-inch high-pressure headers that operate at 500 pounds, two at 1,000 pounds and one at 1,250 pounds respectively.

Extra compressor equipment has recently been installed for the low-stage system.

Successful results from repressuring have been obtained. Due to proration restrictions the possibilities of repressuring are not so apparent as they would have been under normal producing conditions. However, it is expected that restricted production will, in the long run, be beneficial in this field.

Besides the three repressuring projects just described there are many old fields in the state being repressured. Repressuring work is in progress in many of the shallow fields in Callahan County; in the Petrolia field in Wichita Falls district; in the wells operated by the Government north of Burkburnett, and in many fields in Central West Texas. Also repressuring is used to a small extent in old depleted fields of the Gulf Coast. Repressuring operations have been tried in the Saratoga Dome field with indifferent success.

One of the difficulties of repressuring in old depleted fields is the diversified ownership of the various leases in the pool. There must be a working agreement among operators whereby each will conform to a method of production that will insure a reasonably uniform distribution of pressure, and a minimum by-passing of the gas in the sand. Too much by-passing will result in high gas-oil ratio in some wells and may lead to serious energy losses that will render the repressuring operation unprofitable. The present status of many of these projects and the results being obtained are difficult to ascertain. Low crude prices and the curtailment restrictions has compelled the shutting in of many areas. Others again, where it is economical

to do so, are taking advantage of the existing conditions to build up and equalize rock pressures.

With the progress being made in the application of the gas-lift, repressuring offers interesting possibilities as an economical method of operation in certain areas. On many properties the cost of repressuring cannot be accurately estimated. All producers in Texas, however, realize that they cannot afford to overlook its possible use in view of what has already been accomplished in the fields of the state.

The Texas Panhandle

(*Continued from page* 111)

ficult to move equipment in or petroleum out. Actual exploration began in 1917. The next year a discovery gas well was struck in Potter County, and in 1921, in Carson County, the first oil well was found. By the end of 1925 transportation and storage facilities had been provided and drilling was commenced in earnest.

The peak annual production occurred in 1927 when 49,000,000 barrels were produced. In 1928 the production fell to 25,000,000 barrels, but in 1929, on account of important discoveries in Gray County, the total increased to 31,000,000 barrels. The production has held near this figure during the following year.

Of the 32 counties included in the Texas Panhandle, seven produce oil and gas and three produce gas alone. The district's gas production is estimated to represent the world's largest gas field. A staggering total is taken from the area and transported thousands of miles to domestic markets in the north. Several of the world's largest natural gas transmission systems originate in this district. The largest is the Natural Gas Pipe Line Company's project from Fritch, Texas, to Chicago, a 24-inch combination coupled and welded line. Ten major gas trunk systems originate in the Panhandle and deliver gas to twelve states.

Another important allied industry in the Texas Panhandle is natural gasoline manufacture, in which it leads all producing districts in the world. More than 300,000,000 gallons of casinghead gasoline is made in the Panhandle every year.

The Texas Panhandle contains twenty-four manufacturing carbon black plants—over one-third of the total number in the United States. These plants manufacture about 54 per cent of the total carbon black produced in the world. All of the gas is procesesd for gasoline before burning in these plants.

Located in Amarillo is the largest helium plant in the world. This is operated by the United States Government and is described in detail elsewhere in this issue.

The Panhandle area has a promising outlook for future development, which has been retarded in recent years by proration regulations. Indications are that when development is warranted, the known pools and defined trends of production will be extended with full confidence of finding commercial production.

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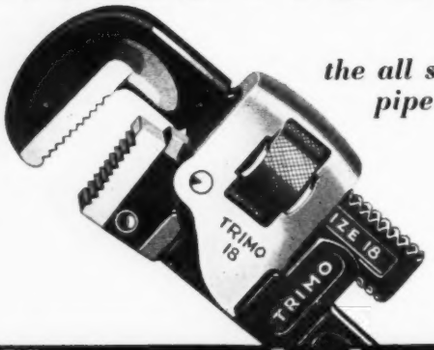

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Oil and Wichita Falls

(*Continued from page* 113)

to meet the onrush of thousands who flocked into the city following the bringing in of the famous Fowler well which brought with it the greatest boom period the country has ever seen. This period of millions overnight lasted through 1920 when a slight depressed condition nationally brought a let-down in the local territory.

Many operators with heavy obligations were temporarily wiped out; but a change in conditions beginning with 1921 saw a rise in the oil industry for the next six years which prompted the greatest development and production yet known here. New extensions were made; new sands brought on added activity; production rose, and each year records for output were broken. And in spite of a slight drop in prices during 1928-1929, the latter year's production record beat the supposedly high peak of 1920 by 2,699,500 barrels.

Proration laws of the past 18 months have lessened actual output but have by no means cut down potentials. In fact, the community subscribed capital of the million dollar Deep Oil Development Company has been used to explore with success deeper sands than had previously been tried, money being made by the company from the beginning. Deep sands have been found productive in new locations which men who can speak authoritatively declare will give this section far greater production than was ever known during the boom days and the great years which followed.

Over 24,000 producing wells are to be found in the Wichita Falls area. Some of these have been in constant production since 1904. Most of the wells brought in during the Burk boom period are still producing in paying quantities after having paid for themselves hundreds of times. This section is especially famous for the stability of its production.

Wichita Falls is now completely circled by rich oil fields and so located geographically at the center of the Texas and Oklahoma pools that its operators find it easy to watch holdings in all of them.

The immediate Wichita Falls area has 17 refineries capable of handling much of the teritory's production. All of them are connected by pipelines to all production of the section, there being no district in the world better served by pipe lines.

Wichita Falls has truly had a happy past. Those of us who live here believe we have a great future. Being so thoroughly entrenched in a field which has proved itself many times and then gone ahead to outstrip itself with new pools, there can be nothing false in the prediction that this district will experience a far greater future than anything known in a great past.

Southwest Texas

(*Continued from page* 114)

1921 with the Luling pool coming one year later to definitely stamp the region as a producing district of real consequence.

In 1929, Salt Flat, Darst Creek and the Refugio fields attained major ranking and the attention of the entire oil industry was attracted to Southwest Texas. The most active development in its history has followed with the discovery of numerous pools, several of which have gained considerable prominence for their producing records.

The district continued to hold the interest of the operators during the years 1930 and 1931, with the Pettus field the most important strike. At this time more attention is being given to Southwest Texas as an important potential producing district than the area has ever received before. Outside of East Texas, the region is the most active in Texas and has several concentrated drilling campaigns under way. Numerous discoveries during the past four months has given impetus to drilling operations and indications are that the remainder of the year 1932 and the year 1933 will witness some real developments in the regions.

John B. Corrin Dies

John B. Corrin, vice-president and general manager of the Hope Natural Gas Co., Pittsburgh, Pa., died very suddenly at Clarksburg, West Virginia, August 27th. He was in Clarksburg for the purpose of attending the annual outing of the Hope employees.

John B. Corrin

Mr. Corrin has been an outstanding figure in the natural gas industry for many years, taking a leading part in the activities of several associations. He was one of the early members of the Natural Gas Association of America, which later became the Natural Gas Department of the American Gas Association. He served as president of the association in 1924-25 and was on the board of governors. Mr. Corrin served on the committee of ten selected by the Secretary of the Interior Lane for the purpose of making definite recommendations regarding problems outlined in resolutions of the national conference on natural gas conservation sponsored by the U. S. Bureau of Mines.

Mr. Corrin entered the services of the South Penn Oil Co., at Oil City, Pa., in 1890 and rapidly rose to place of leadership. In 1902, he went to Pittsburgh as assistant treasurer of the Hope Natural Gas Company, from which position he gradually and steadily rose to the one held at the time of his death.

Current Activities of A. S. T. M. Committee D-2 on Petroleum Products and Lubricants

A. S. T. M. Committee D-2 on Petroleum Products and Lubricants has several important projects before its various subgroups. The working groups in Committee D-2 are subcommittees and technical committees, the former concerned with the development of methods of test and the latter with the relation between test data and service performance of materials and with the preparation of materials specifications.

The oustanding features of the subcommittee program are as follows:

Subcommittee IV on Grease is giving further study to the Tentative Method or Test for Penetration of Greases and Petrolatum (D-217—27-T) particularly with respect to its use on hard greases.

Subcommittee V on Viscosity is co-operating with representatives of Committee D-9 on Electrical Insulating Materials on the determination of the viscosity of electrical insulating oils at temperatures around O° C.

Subcommittee VIII on Distillation is developing a method for distillation of petroleum oils under vacuum.

Subcommittee X on Sligh Oxidation Test is a new subcommittee organized to perfect the Sligh oxidation test so that reproducible results may be obtained.

Subcommittee XII on Flash Point is studying the determination of the flash point of cut-back asphalts and similar materials.

Subcommittee XXI on Crude Petroleum is developing a method for evaluating crude petroleum.

Subcommittee XXVII on Classification of Transmission Lubricants and Automotive Greases has been requested to prepare a classification of automotive greases based upon consistency and the viscosity of the mineral oil content.

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Progress in Refining Technology

THE technical papers presented before the Petroleum Division of the American Chemical Society at the Denver Meeting last month illustrate the progress being made in the solution of some of the manufacturing problems encountered in present day refining. A brief summary of several of these papers is given here.

The computation of distillation apparatus for hydrocarbon mixtures was discussed by E. W. Thiele and R. L. Geddes. The development of columns for use in the petroleum industry has been hampered by the lack of a method for computing the performance of a proposed column, so that the design of equipment, so far as reflux ratio and number of plates are concerned, has depended on experience only. After a number of years of laboratory work a method has been developed for the solution of column problems involving complex mixtures obeying Raoult's law or some simple modification of it. A constant plate efficiency for all components is assumed. The number of components may be either finite or infinite. The method is extended to cases in which side streams are drawn from the column, or the feed is admitted at more than one point.

By use of the methods outlined it appears that the complete solution of any column, no matter how complex, is possible to a degree of accuracy which is limited only by the available knowledge of the equilibrium relationships and of the plate efficiencies.

The measurement of the gum stability of gasoline was discussed in a paper by T. H. Rogers, J. L. Bussies, and P. T. Ward. Cracked gasolines are unstable and form gum upon ageing in the presence of air. Cracking developments have served to emphasize the importance of this question, since the trend is toward a higher percentage of cracked naphtha in finished gasoline.

The major problems confronting the gasoline manufacturer are: the development of a sound method for predicting stability, and finding a suitable means of attaining the desired stability cheaply and satisfactorily. Complete information regarding the oxidation characteristics of a gasoline are given by an accelerated oxidation test developed by Voorhees and Eisinger, involving the determination of the amount of oxygen absorbed, which is a measure of stability. This stability test was found to be a sound method for predicting the storage behavior of gasoline. The irregularities of the conditions imposed in practical storage are such that a factor of safety, as regards stability must be used by the refiner.

It is pointed out that aging of unstable gasoline results in loss of anti-knock value as well as gum formation, although the relation between the two types of deterioration is rather uncertain.

T. H. Rogers and Vandeveer Voorhees presented a paper on the control of gum formation in gasoline by the use of antioxidants. The effectiveness of the substituted aminophenols as antioxidants is so great that the cost for a given degree of stabilization is less than that for other practical inhibitors tested. From the data available it appears that the color stability and the solubility characteristics of p-benzylaminophenol are such that it is the most suitable antioxidant in this class.

A paper by Lowry, Egloff, Morrell and Dryer presented a correlation between inhibiting power, as measured by the accelerated oxidation test, and critical oxidation potential. Compounds of low potential are in general powerful inhibitors. In general the best inhibitors tested had critical potentials between .600 and .797 volts, fair inhibitors were in the range .799 to 1.043 volts, and compounds with potentials above the

latter figure were ineffective. This correlation is not alone valid for gasoline, but holds for the use of inhibitors in other oils.

M. G. Blair and R. C. Alden discussed the significance of the A. S. T. M. distillation curve, correlating the performance characteristics of a motor fuel with its curve. Extending the value of the curve means has been devised to graphically estimate the butanes and lighter, pentanes, hexanes, and heptanes and heavier content of gasolines. The Reid vapor pressure of a gasoline can be estimated from values derived from the A. S. T. M. distillation curve. The composition, API gravity, and Reid vapor pressure of natural gasoline can be determined from its distillation data.

The effect of tetraethyl lead on octane number was outlined by Hebl, Rendel, and Garton. Five factors determine the octane number of any ethylized gasoline: the effectiveness of iso-octane at different concentrations in raising the antiknock value of iso-octane-heptane mixtures; the effectiveness of tetraethyl lead at different concentrations, the octane number of the base gasoline before tetraethyl lead is added, the lead susceptibility of the gasoline, and the number of cubic centimeters of tetraethyl lead added per gallon of gasoline.

Vapor phase cracking, including the chemistry, effect of temperature, rate of throughput, and the nature and yields of products was covered in a paper by H. P. A. Groll. An apparatus and method for determining the total heats of gas oils at elevated temperatures and pressures was outlined in a paper by Gary, Rubin, and Ward. Neuhaus and Marek presented a paper on the decomposition of isobutane into primary products.

Walter J. Podbielniak presented a number of papers: The products of commercial scale gas cracking, Distillation at higher temperatures, Apparatus for precise fractional analysis.

Selenium as a catalyst in the Kjeldahl determination of nitrogen in oil as a time-saver was demonstrated by the work of Baxter, Howe and Schultz.

A. S. Crutcher Joins W-K-M

A. S. Crutcher, who, since 1926, has been prominent in the development and sale of specialized pipe line equipment, has been named manager of sales of the pipe line equipment division of the W-K-M Company, Inc., Houston, Texas. Mr. Crutcher recently returned from a three-months' trip to England and France, where he successfuly negotiated the sale of more than sixteen carloads of W-K-M pipe line equipment for use on the Iraq Pipe Line, a 1,200-mile project extending from Kirkuk, Iraq, to Haifa, Palestine, and to Tripoli, Syria.

A. S. Crutcher

J. D. Cummings, inventor and patentor of many items of W-K-M Pipe Line Equipment, will collaborate with Mr. Crutcher in the sale of W-K-M Equipment. Both men are well known to pipe line executives, engineers and field men throughout the United States. Mr. Crutcher will spend part of his time abroad, making contacts in foreign countries and advising on equipment suitable for use on foreign pipe line projects.

Aviation Gasoline

The Shell Petroleum Corporation was recently awarded a contract by the War Department to supply the majority of Zone 3 U. S. Army airports with fighting grade, anti-knock aviation gasoline. The estimated semi-annual requirements of the fields to be supplied approximate nearly 500,000 gallons.

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Fig. 651. Jenkins Standard Iron Body Solid Wedge Gate Valve, Outside Screw.

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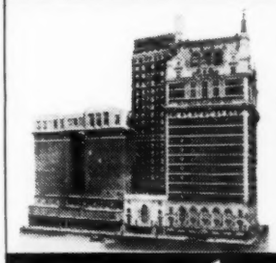

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Texas Panhandle . . . The Center of the Carbon B

DURING 1931 approximately 75 per cent of the Nation's production of carbon black was manufactured in Texas. Since 1928 the largest producing area in the country has been the Texas Panhandle. From 1921 to 1928 Louisiana was the leading carbon black producing state.

The strongest demand for carbon black is in the rubber industry, the commodity being used as a filler and pigment in tires and other goods. It is also used in the manufacture of printers' inks, paint, carbon paper and many miscellaneous articles.

Carbon black is produced from natural gas in most plants by either the contact or retort method. In the contact method the black is deposited when a flame impinges on a cold surface. In the retort process the black is produced by the thermal decomposition of natural gas. The average yield of carbon black is less than 1.5 pounds per thousand cubic feet of gas by the contact method, while the yield is as high as 10 pounds by the retort method.

The first carbon black plant was completed in the Big Lake field in West Texas early in 1931. It consumed residue gas from a natural gasoline plant in the field.

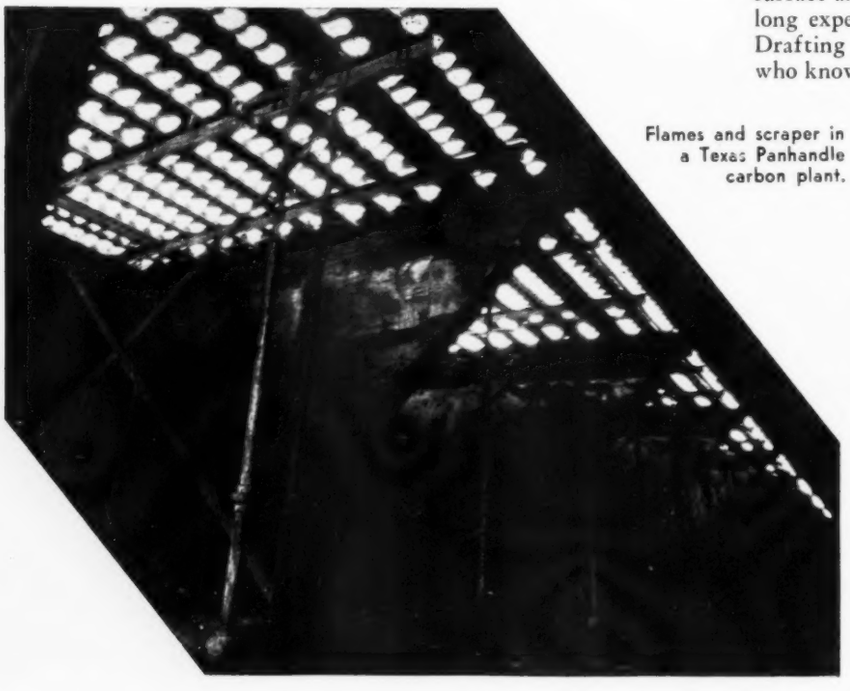
The plant of Godfrey L. Cabot, Inc., in the Texas Panhandle is the largest in the world. There the contact or channel process is used, as is the case in most Texas plants. While the poundage obtained by a single flame is very small, there are in the Cabot plant 1,140,480 individual flames. The collecting surfaces consist of eight-inch channel irons weighing about eleven pounds per foot. There is over ninety miles of surface in this plant, necessitating about 120 miles of pipe. The plant consumes 58,000,000 cubic feet of gas and produces 100,000 pounds of carbon black per day.

This factory covers 11.3 acres of ground and consists of 288 buildings for burning, each 140 by 14 feet. About eight miles of screw conveyor is required to carry the black to the packing house. The plant was wholly constructed by arc welding.

Carbon Black Plants in Texas*

Company	*County*	*Town*	*Process*
Cabot Carbon Co.	Gray	Pampa	Channel
	Hutchinson	Wewauka	Channel
Cabot Company	Carson	Skellytown	Chan. & Roller
Coltexo Corporation	Gray	Lefors	Channel
	Stephens	Parks	Channel
Crescent Carbon Co.	Hutchinson	Borger	Channel
Eastern Carbon-Black Co.	Hutchinson	Borger	Chan. & Disk
		3 Plants	
General Atlas Chemical Co.	Gray	Pampa	Special
J. M. Huber Company	Hutchinson	Borger	Channel
Kosmos Carbon Company	Hutchinson	Borger	Channel
		2 Plants	Channel
Magnolia Petroleum Co.	Carson	Skellytown	
	Gray	Pampa	Channel
	Stephens	Breckenridge	Channel
	Wheeler	Lela	Channel
Palmer Carbon Company	Hutchinson	Borger	Channel
Panhandle Carbon Company	Hutchinson	Borger	Channel
Peerless Carbon-Black Co.	Eastland	Pioneer	Special
Texas Carbon Ind., Inc.	Stephens	Breckenridge	Channel
Texas Elf Carbon Company	Gray	Pampa	Channel
	Stephens	Eliasville	Channel
Western Carbon Company	Eastland	Pioneer	Channel
	Gray	Kings Mill	Channel
	Gray	Lefors	Channel
	Gray	Pampa	Channel
	Hutchinson	Borger	Channel
	Wheeler	Lela	Channel
	Wheeler	Magic City	Channel

*U. S. Department of Commerce.



Flames and scraper in a Texas Panhandle carbon plant.

C. S. Dewey[1] points out that both the yield and the quality of the carbon black produced in a burning shed are dependent upon many factors over which the operator has but partial control. The best shape of the flame, which is regulated by the burner tip design, and the best distance to the collecting surface and to other tips, have been established after long experimenting with each different gas supply. Drafting of the building is done by experienced men who know the best color of the flame and proper appearance of the smoke for optimum production and quality. Conditions in the burning shed change with the weather. No successful system of automatic draft control has yet been devised.

During 1931 nearly all of the countries buying carbon black from the United States increased their purchases. The United Kingdom is the leading customer, followed by France and Germany. Canada ranks fourth and Japan fifth.

Carbon black is produced in the Thermatomic[2] process by cracking natural gas at a temperature from 900 to 1,400 degrees C. The cracking unit consists of a retort or furnace made of a steel shell fourteen feet in diameter and twenty-five feet high with a spherical dome and

[1]Petroleum Engineer, September, 1930.
[2]Chem. & Met. Engineering, July, 1932.

Black Industry

. . . Three-fourths of Nation's Output Manufactured in Texas

a water gas stack lid. The shell is lined with firebrick and insulated. It is filled with checker brick to store heat. The stack lid is closed and natural gas is admitted into the top of the furnace, passing down through the previously heated checker work. The products leaving the bottom of the furnace consists of hydrogen and half of the dissociated carbon in suspension. The remainder of the dissociated carbon deposits on the surface of the checker brick of the furnace.

After five minutes the gas is shut off at the top of the furnace, the stack lid is opened and a blast of air and heating gas enters the furnace at the bottom. This stream of gas and air ignites immediately in contact with the hot brick work in the furnace. It is heated for five minutes by the combustion of the heating gas and the carbon remaining from the previous run.

The products from the furnace enter a vertical cooling chamber, containing atomizing water sprays, supplied through an automatic temperature controller. The cooling is effected by the evaporation of the spray water. The solid carbon is carried in a superheated atmosphere. The products from the cooler enter a cloth bag which separates the solid carbon from the gas and steam. The carbon from the filter bags is removed from the collector hoppers by an enclosed conveyor, which carries it to the screening and packing department where it is put into paper bags.

Although extensive research work has been conducted by the manufacturers of carbon black its chemical composition is still in doubt. It is not pure carbon, but is a mixture of hydrocarbons. The best grades contain about eighty-five per cent carbon.

The Bureau of Mines reports that the stocks of carbon black held at plants has been accumulating in recent years. The weakening prices has forced some of the high-cost producers to suspend operations. There were only twenty-six producers in the country in 1931, compared with thirty-three in 1930. In spite of curtailment in production, stocks increased approximately twenty million pounds. The total value of carbon black produced in 1931 was about six million dollars less than the value in 1930.

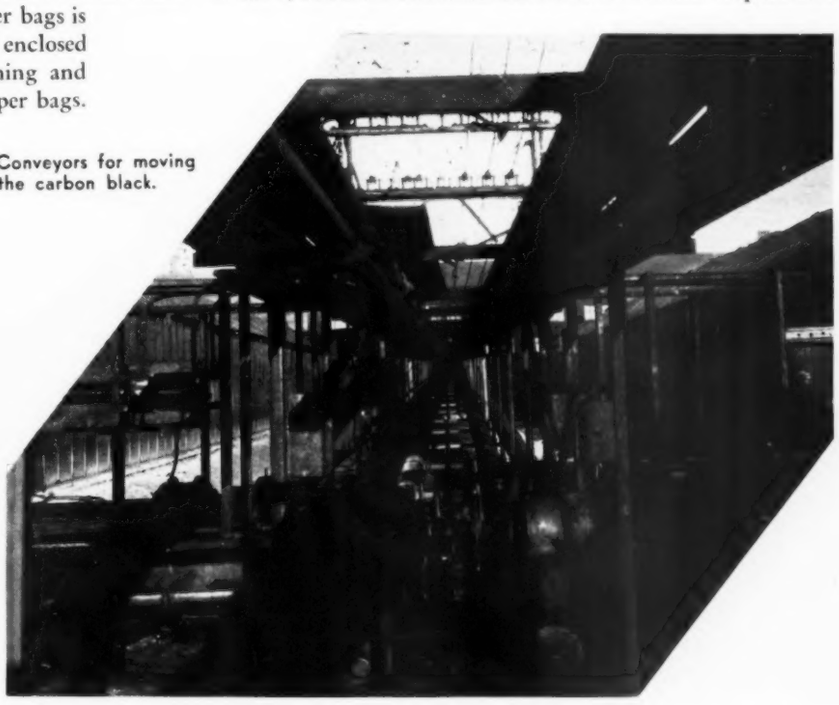
The Primary Statistics of the Carbon-Black Industry in 1930 and 1931 were as follows:*

	1930	1931
Number of producers reporting	33	26
Number of plants	68	58
Quantity produced (pounds):		
Louisiana	96,729,000	57,485,000
Texas:		
Panhandle District	254,844,000	197,546,000
Breckenridge District	16,905,000	13,332,000
Other States	11,464,000	12,544,000
TOTAL	379,942,000	280,907,000
Produced by:		
Channel Process (pounds)	350,254,000	255,322,000
Other processes[1] (pounds)	29,688,000	25,585,000
Stocks held by producers December 31 (pounds)	259,245,000	280,010,000
Losses (pounds)	1,361,000	1,716,000
Sales (pounds), Domestic:		
To rubber companies	128,572,000	134,315,000
To ink companies	19,220,000	15,184,000
To paint companies	11,922,000	6,760,000
To miscellaneous companies	7,565,000	5,453,000
TOTAL	167,279,000	161,712,000
Export	84,260,000	96,714,000
Value (at plants) of carbon-black produced:		
Total (dollars)	14,852,000	8,621,000
Average per pound (cents)	3.91	3.07
Estimated quantity of natural gas used (M cubic feet)	266,471,000	195,396,000
Average yield per M cu. ft. (lbs.)	1.43	1.44

[1]Including disc, roller, "special", and thermatomic.

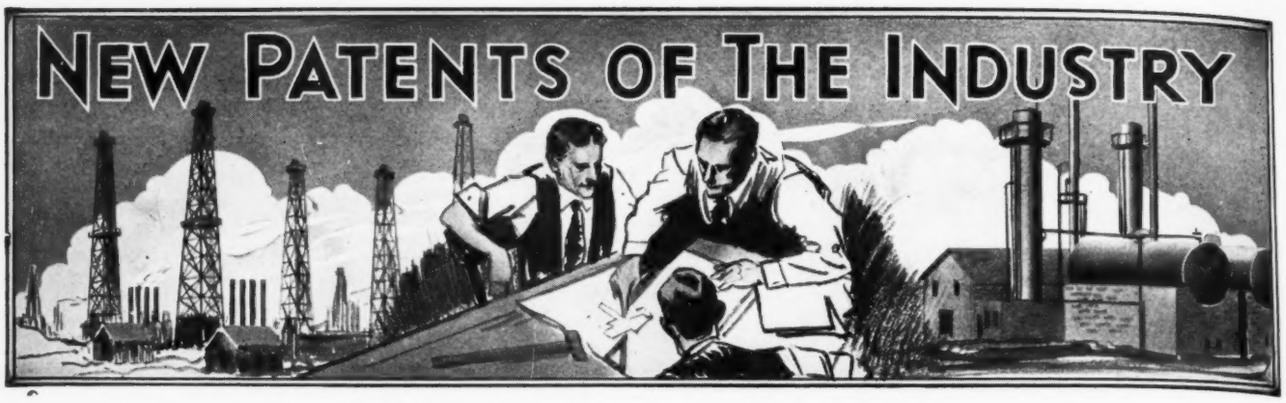
*By G. R. Hopkins, Petroleum Economics Division U. S. Bureau of Mines.

Although the output of the plants in the Texas Panhandle area fell off materially in 1931, the decline in most of the other producing areas was even more severe so that the relative importance of the Panhandle area was considerably enhanced. Production in Louisiana declined over forty per cent in 1931. The output of the other producing states increased in 1931, but their combined total is still of minor importance.



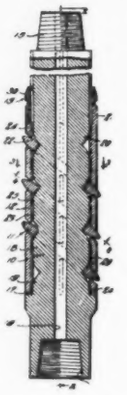
Conveyors for moving the carbon black.

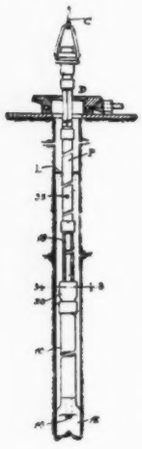
NEW PATENTS OF THE INDUSTRY



1,861,702. REAMER. VAN J. KUBIN, Brea, Calif., assignor to Chiksan Oil Tool Co., Limited, Fullerton, Calif., a Corporation of Nevada. Filed Aug. 25, 1930. Serial No. 477,628. 13 Claims. (Cl. 255—73.)

4. A well tool of the character described including a body having a plurality of contiguous spherically rounded parts, and cutters mounted on the rounded parts to rotate in planes tilted relative to the axis of the body.



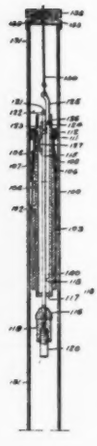


1,867,833. SUBCIRCULATION OIL WELL DRILLING APPARATUS WITH SUCTION PUMPING. FRANK F. HILL, Los Angeles, Calif., assignor to Union Oil Company of California, Los Angeles, Calif., a Corporation of California. Filed June 6, 1928. Serial No. 283,282. Four claims. (Cl. 255—28).

1. In a structure for drilling a deep well, a hollow drill stem comprising two telescoping sections, a drill on the lower end of the lower section, said drill having a water course therethrough, a driving connection between the two sections extending throughout the range of their telescopic engagement, and an upwardly opening valve in each section.

1,874,035. WELL STRAINER AND PROCESS OF MAKING SAME. HAROLD W. FLETCHER, Houston, Tex., assignor to Hughes Tool Company, Houston, Tex., a Corporation of Texas. Filed Sept. 12, 1931. Serial No. 562,531. 5 Claims. (Cl. 166—5.)

1. A well screen comprising a tubular member made up of metal shot bonded to each other at their points of contact, a metallc socket at one end and a pin at the other end of said member cemented to said shot whereby said member may be secured to adjacent pipe connectons.

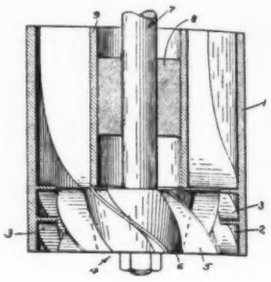


1,874,114. TUBING PLUG. HERBERT C. OTIS, Shreveport, La. Original application filed Feb. 26, 1930, Serial No. 431,510. Divided and this application filed Aug. 19, 1931. Serial No. 558,157. 8 Claims. (Cl. 166—13.)

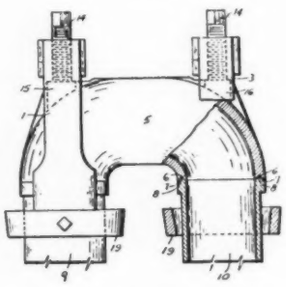
1. A tube-sealing unit comprising a hollow core member, a packer surrounding the core member for providing a seal between the tube and the core member, a valve for closing the hollow core member at one end thereof, a rod supporting the valve and passing through the core member to the opposite and end thereof, and a shoulder on the rod adjacent the last said end of the core member and arranged to be hooked on the said adjacent end of the core member for securing the valve in closing relation to the first said end of the core member.

1,874,450. DEEP-WELL TURBINE PUMP. GEORGE S. COATS, Visalia, Calif. Filed Nov. 5, 1930. Serial No. 493,664. 6 Claims. (Cl. 103—90.)

4. A deep-well turbine pump comprising a casing having inwardly extending and inclined blades, a runner having blades inclined in the opposite direction and being disposed opposite the first named blades, means for rotating said runner at a high speed, alternate blades of the casing extending beyond the runner and being gradually curved for extending in a straight line paralleling the axis of the runner, said extending casing blades projecting over the hub of the runner, and a bearing for the runner carried by the casing blades.



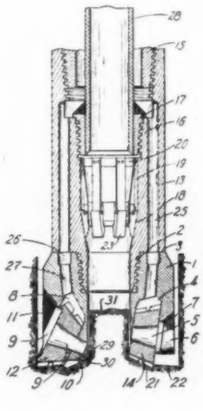
1,874,004. RETURN BEND FITTINGS FOR OIL STILLS. FRED C. FANTZ, Webster Groves, Mo. Original application filed Dec. 8, 1931, Serial No. 579,707. Divided and this application filed Feb. 3, 1932. Serial No. 590,628. 6 Claims. (Cl. 285—20.)

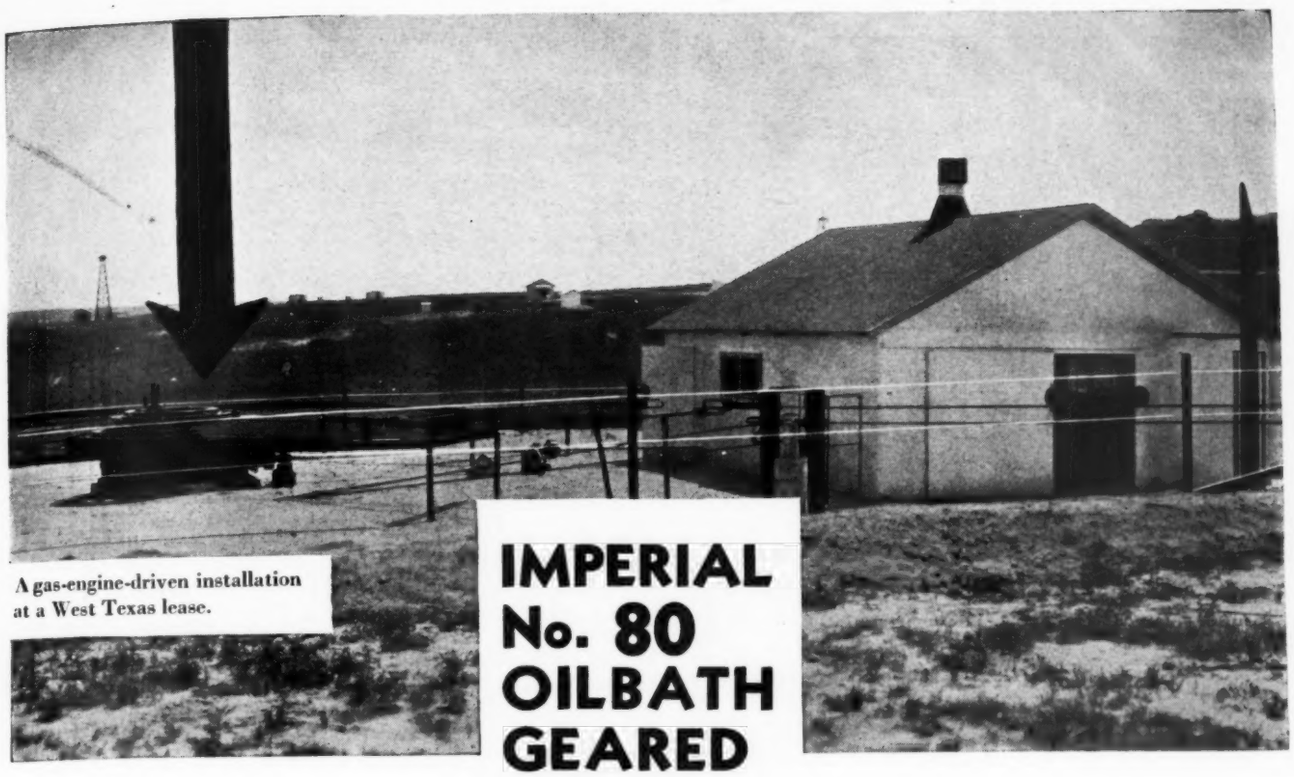


1. In a refinery apparatus, a return bend, a pair of shouldered tubes communicating therewith, a compound housing therefor, comprising complementary sections adapted to partially encircle the ends of said tubes and to be locked to the shoulders on the tubes, detachable means mounted in said housing sections to hold said tubes and return bend in a tight joint, extensions on said housing sections which contact said tubes, securing means to contact said extensions and hold said sections together, and outer surface of said extensions tapering downwardly and inwardly, said securing means having tapered apertures which fit said extensions whereby said sections are held together.

1,874,065. ROLLER CORE BIT. FLOYD L. SCOTT, Houston, Tex., assignor to Hughes Tool Company, Houston, Tex., a Corporation of Texas. Filed July 5, 1928. Serial No. 290,292. 4 Claims. (Cl. 255—72.)

1. A core drill including a tubular head, an outer set of cutters mounted in pockets in the lower end of the head, pins upon which said cutters are rotatable, said pins being tapered and inclined downwardly at their inner ends, said inner ends of said pins being supported in the wall of the head, and an inner set of cutters mounted upon tapered pins inclined upwardly at their inner ends, said inner cutters projecting in advance of the said outer cutters and serving to cut a clearance for the wall supporting said outer cutter pins.





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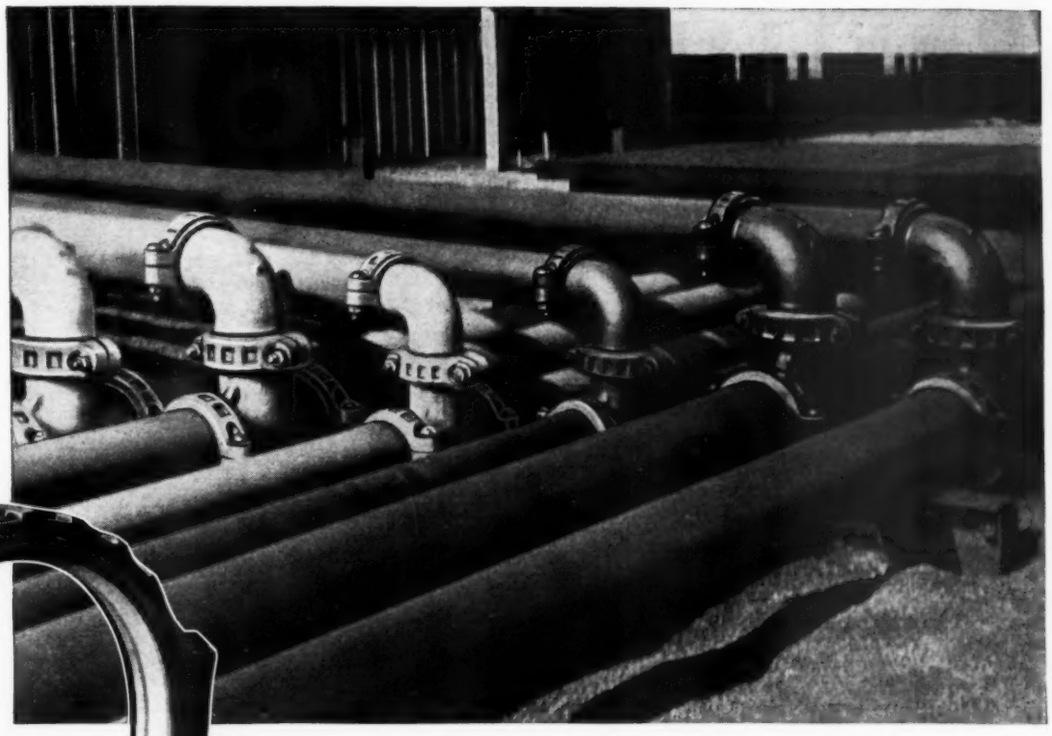

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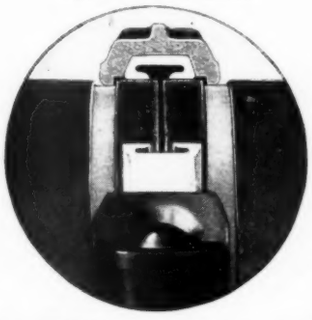

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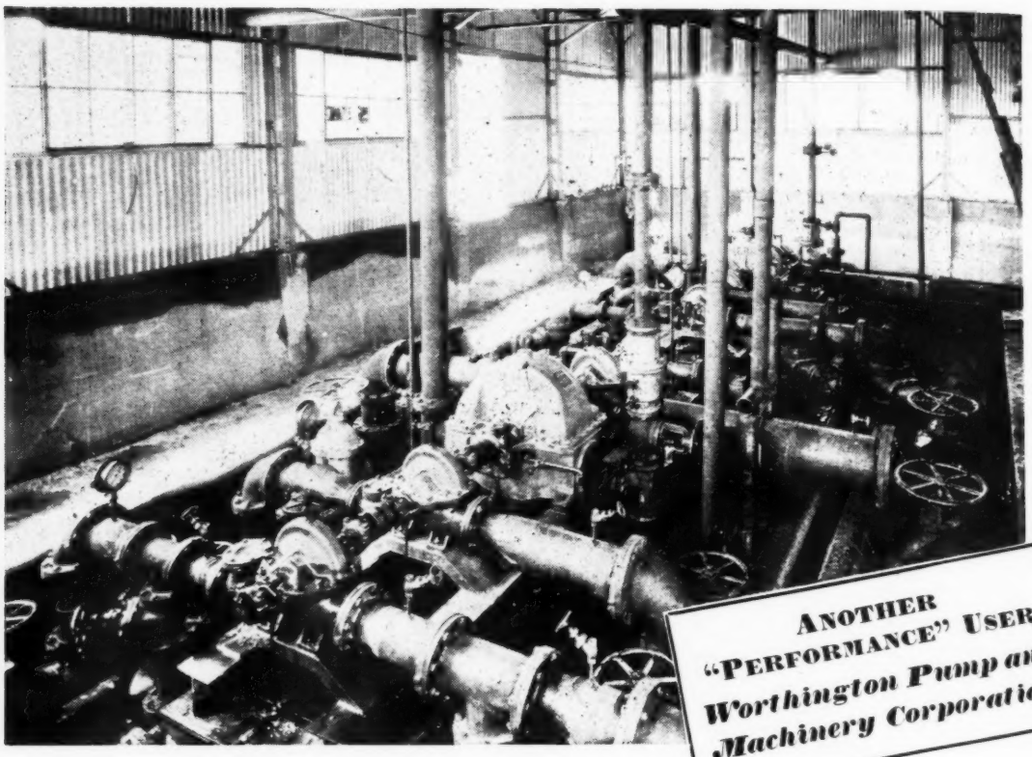
RELIABILITY OF PUMPS WITH SKF UNQUESTIONED



ANOTHER "PERFORMANCE" USER
Worthington Pump and Machinery Corporation

WHERE PERFORMANCE TAKES PREFERENCE OVER PRICE

PUMPS . . . and the oil industry are inseparable. Twenty-four hour reliability is demanded of this highly important equipment. Performance is the only thing that counts in bearings for this field and these Worthington pumps are fully protected with SKF Ball Bearings against interruptions of service and lost production.

The initial high efficiency of pumps is maintained throughout a long life, for SKF Bearings show no wear, require no adjustments and therefore enable close tolerances to be kept indefinitely. Their ruggedness gives an ample margin of safety for the unexpected requirements. With comparatively little attention they keep going day after day insuring dependable and economical operation.

● *You may buy a bearing as a bargain but try and get a bargain out of using it, for nothing is apt to cost so much as a bearing that cost so little.*

SKF INDUSTRIES, INC. 40 EAST 34th STREET, NEW YORK, N. Y.

2933

SKF

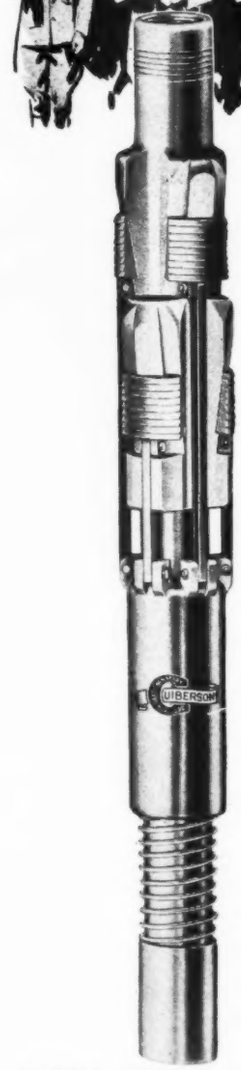
Ball and Roller Bearings

YOU CAN HALT AN ARMY
WITH A SINGLE COMMAND

BUT IT TAKES MORE THAN A COMMAND TO STOP A STRING OF FALLING TUBING

Of course you have to be the "General" or "Big Boy" in the army, but most of us have the idea that we are the "Big Boy" all right, when occasion demands. That's why you ought to be tipped off about tubing, and here's the tip: When your tubing falls, and there's no catcher attached, you're lower than a buck private in the rear rank. And your pocketbook sinks correspondingly with the expense of ruined tubing, bottled up production, a fishing job, if not a ruined well.

The Guiberson Tubing Catcher stops a string of falling tubing neatly and positively within three inches. Dove-tail tracks guide the slips instantly and accurately to the casing walls. Strong spring operates with or without fluid in the hole. Heavy striker weight overcomes the retarding action of mud or paraffin. Let the Guiberson Tubing Catcher keep you in the rank of "General" among oil operators.



NEW DUPLEX CATCHER

Developed to meet safety requirements of tubing in deep wells. Multiple slips, actuated by common means, provide greater gripping area, distribute load and ease shock on casing. *Fully Patented.*

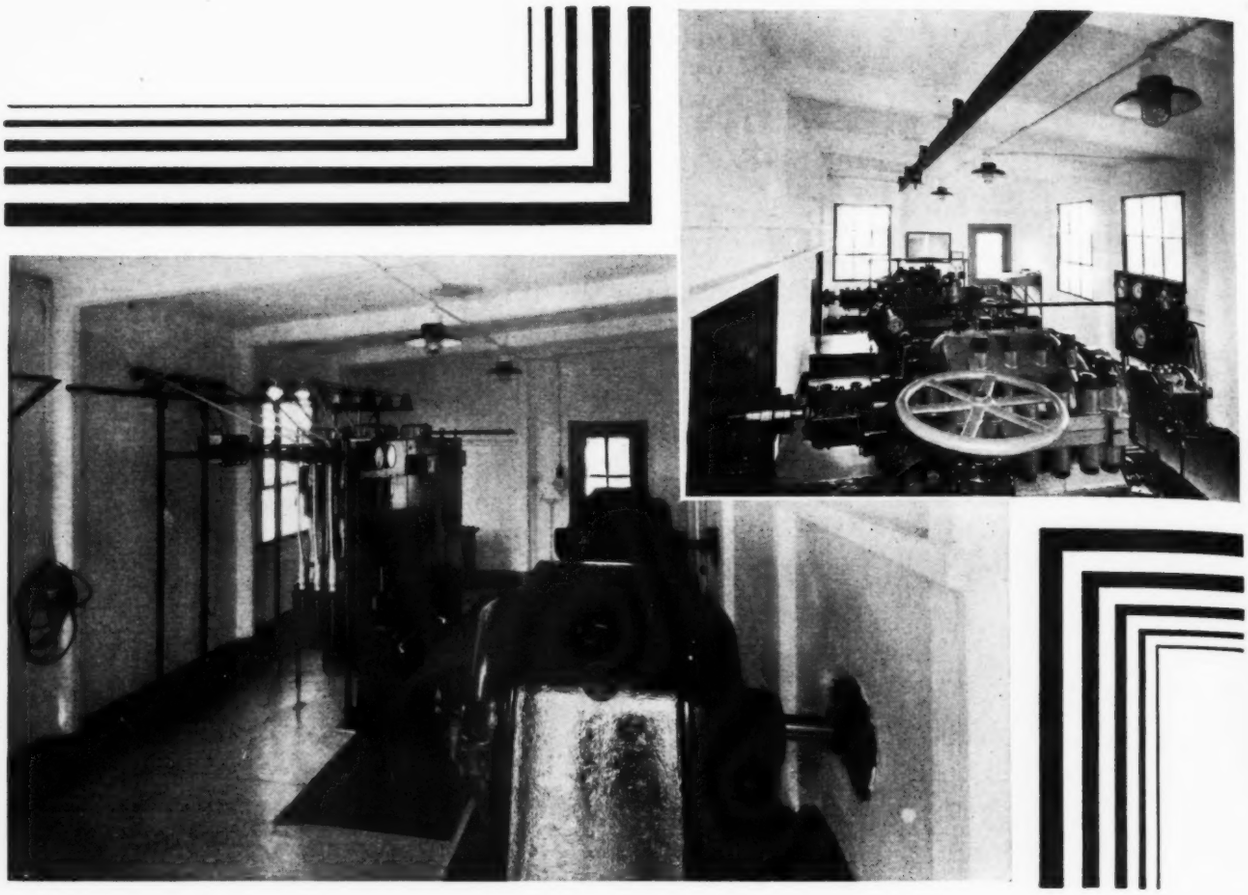
Use a GUIBERSON CATCHER

"Better Be Safe Than Sorry"

The GUIBERSON CORP.
Box 1106, Dallas, Texas
California Branch: 1304 Security Title Ins. Bldg., Los Angeles,
504 Wright Bldg., Tulsa
506 Trust Bldg., Newark, O.

GUIBERSON

BETTER BE SAFE THAN SORRY



40,000 BARRELS A DAY— *ELECTRICALLY*

GENERAL OFFICES: FORT WORTH

DISTRICT OFFICES: FORT WORTH SEYMOUR EASTLAND MIDLAND SWEETWATER BIG SPRING EAGLE PASS WICHITA FALLS

Since November 28, 1928, the above illustrated Atlantic Pipe Line Company's Midland pump station has been operated efficiently and economically by electric power.

The two General Electric 500 H.P., 2200 volt, 1750 r. p. m. electric motors are direct-connected to two five-stage Cameron centrifugal pumps that easily move 40,000 barrels of oil daily when operating at capacity.

Compactness, cleanliness, durability, ease of operation and economy are the principal reasons why this Atlantic Pipe Line Company's Midland pump station has maintained its unusual performance record during the past four years.

Ask for Details of Other Advantages of Electricity in the Transportation of Oil

TEXAS ELECTRIC SERVICE COMPANY

PIPE LINES LAID BY OKLAHOMA

would reach more than twice across the continent . .

References:

Continental Construction Corporation
Producers and Refiners Corporation
Southern Natural Gas Corporation
Oklahoma Natural Gas Corporation
Missouri-Kansas Pipe Line Company
Panhandle Eastern Pipe Line Company
Panhandle Illinois Pipe Line Company
Mississippi River Fuel Company
Ajax Pipe Line Company
Cities Service Company
Shell Pipe Line Company
Lone Star Gas Company
Sinclair Pipe Line Company
Humble Pipe Line Company
Pasotex Pipe Line Company
Canadian River Gas Company

OKLAHOMA CONTRACTING CORPORATION

PIPE LINE ENGINEERING AND CONSTRUCTION

General Offices:
Tower Petroleum Building, Dallas, Texas

Branch Office:
Oklahoma Gas Building, Tulsa, Oklahoma

Many oil executives have established headquarters in Dallas because it is the key city in one of the world's greatest oil regions.

The First National Bank in Dallas is the dominant bank in this great region and knows it intimately, having spent years serving it.

With its large resources, its world-wide contacts, its outstanding board of directors, the First National offers the oil industry the highest type of constructive banking service.

First National Bank
in Dallas.

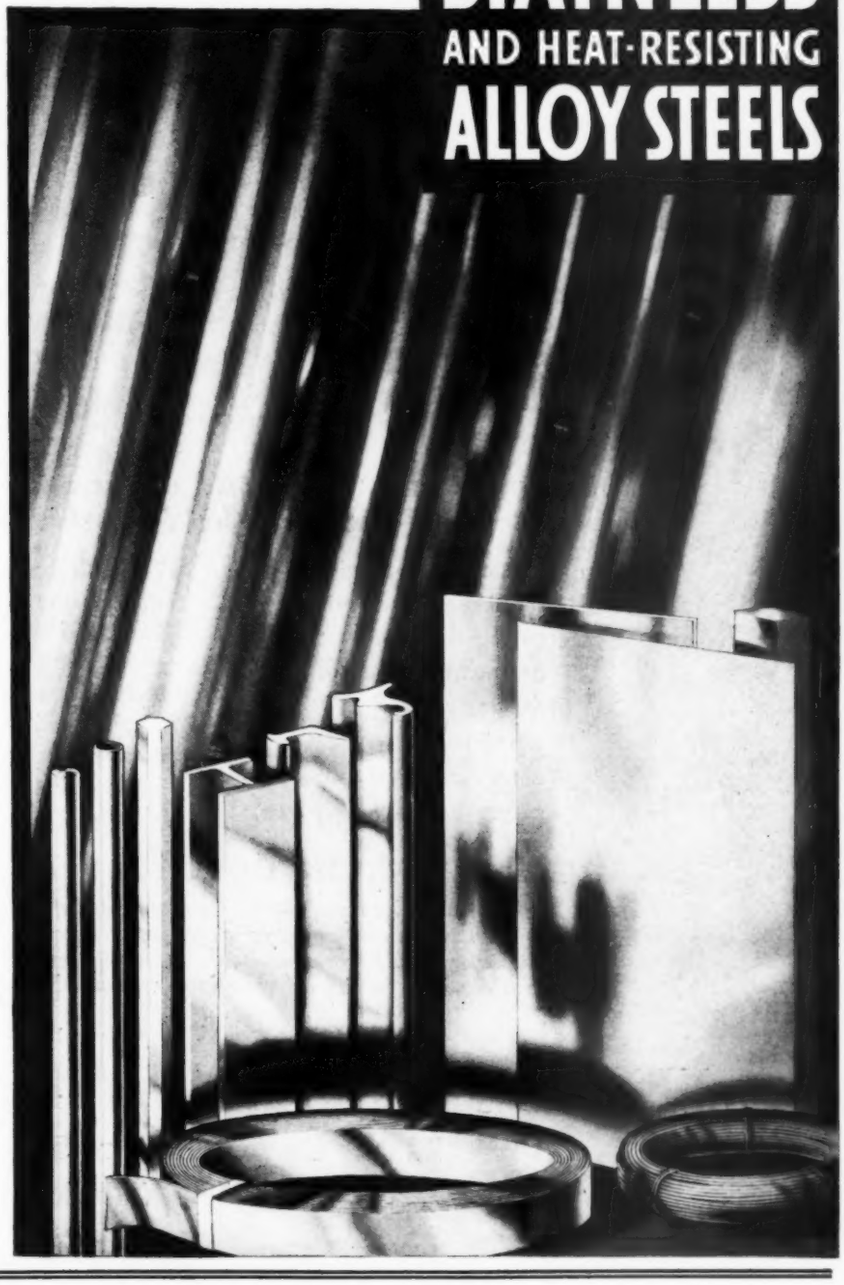
Capital, Surplus and Profits $14,000,000

ACHIEVEMENT

Commanding excellence in the development of Stainless Steel and thorough adaptation of it to industrial needs, including those of the Oil Industry, is achieved only by devotion of resources and effort without stint, to every detail of manufacture. ¶ It is for the most specific and exacting uses that the series of USS Stainless and Heat Resisting Steels have been developed; and they are offered as a distinct contribution to industry, for increased service, economy, and enduring satisfaction.

USS

STAINLESS AND HEAT-RESISTING ALLOY STEELS



These alloy steels are used in oil refining for bubble caps, still tubes, linings, heat exchangers, ducts, containers, tanks, agitators and various other equipment. ¶ For literature and full information, write any of the five subsidiary manufacturing companies of United States Steel Corporation listed below.

AMERICAN SHEET AND TIN PLATE COMPANY, Pittsburgh
Steel Sheets and Light Plates

AMERICAN STEEL & WIRE COMPANY, Chicago
Cold Rolled Strip Steel, Wire and Wire Products

CARNEGIE STEEL COMPANY, Pittsburgh, and ILLINOIS STEEL COMPANY, Chicago
Bars, Plates, Shapes, Special and Semi-Finished Products

NATIONAL TUBE COMPANY, Pittsburgh
Pipe and Tubular Products

Pacific Coast Distributors:
COLUMBIA STEEL COMPANY, San Francisco
Export Distributors:
U. S. STEEL PRODUCTS COMPANY, New York City

USS Chromium-Nickel Alloy Steels are produced under licenses of the Chemical Foundation, Inc., New York, and Fried. Krupp, A. G. of Germany

Supply Companies

- 125 registered buyers of oil field equipment now make their headquarters in Dallas.
- 65 per cent of all wells drilled in the United States last year were within overnight travel from Dallas.
- 65.8 per cent of the oil produced in the United States the first six months of 1932 came from fields accessible by a night's journey from Dallas.
- 38 per cent of all wells drilled in the United States last year were within one to three hours' driving time from Dallas.

These facts definitely establish Dallas as the economic center of the oil industry, the logical location for producing and supply companies.

Known reserves and development trends insure that Dallas will remain central with respect to oil production. Headquarters, once established here, are permanent, obviating the necessity for frequent moves that have characterized the industry in the past.

A recent survey of the oil industry in Dallas reveals the following:

181 producing companies
64 refining and marketing
50 royalty companies
214 independent operators
32 drilling contractors
16 pipe line companies
13 natural gas companies
4 natural gasoline companies
17 consulting geologists and geophysicists
11 petroleum engineers
3 associations
3 map companies
9 pipe line contractors
2 publications
168 companies selling equipment and supplies with headquarters or branches here

NEW DALLAS OIL DIRECTORY AND MAP FREE

A new Directory of the Oil Industry in Dallas and a graphic map showing this city's strategic location are now being prepared. They are available to executives without cost or obligation. Write on your business letterhead to . . . . . .

INDUSTRIAL DALLAS, Inc.

1101 Commerce Street
DALLAS, TEXAS

This carriage salesman laughed at horseless buggies

Three years later
he wished he hadn't.

SOME things are so outstandingly better that they are bound to succeed. The automobile was one of them. Ethyl Gasoline is another.

Success in any business goes to the men who get on the winning side EARLY. Today is not too late to get on the winning side in the gasoline business.

When you make a customer for Ethyl, you are making a customer that will pay dividends for a long time to come. When you make a customer for ordinary gasoline, you are inviting someone else to sell him on *his* Ethyl Gasoline.

In just nine years Ethyl has grown from a laboratory experiment to the biggest selling brand of motor fuel in the country. Sales are going to *go on* increasing. Nearly every major car manufacturer is *already* making engines that are *designed* to run on Ethyl Gasoline.

If you want a big share of tomorrow's business, put your effort on Ethyl today. Ethyl business stands by you. It pays. Ethyl Gasoline Corporation, New York.

WITH ETHYL FLUID — ANTI-KNOCK — ETHYL GASOLINE CORPORATION — Controls Combustion

GOOD GASOLINE + ETHYL FLUID = ETHYL GASOLINE

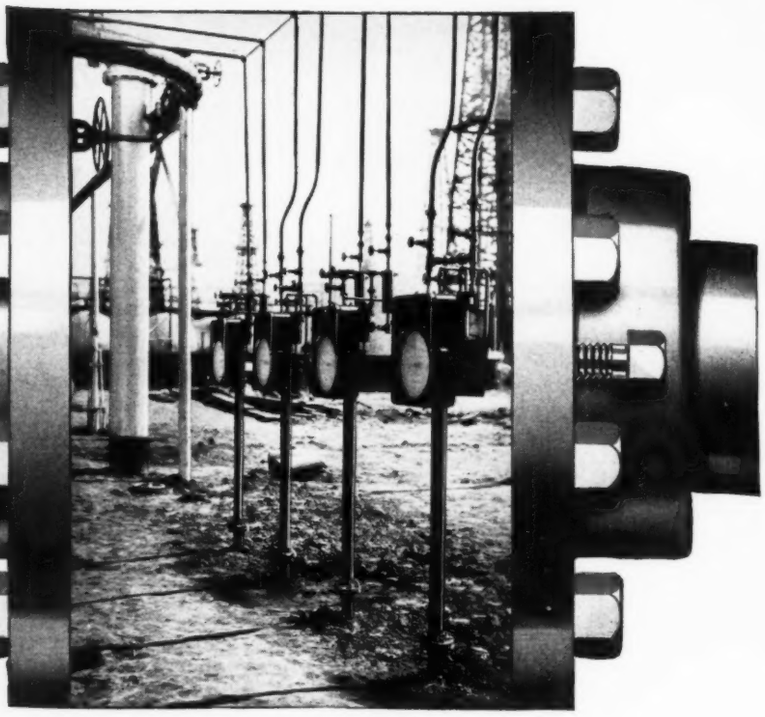
Ethyl fluid contains lead

PUT YOUR EFFORT ON ETHYL—

IT IS THE GASOLINE ROAD TO SUCCESS

© E. G. C. 1932

The Modern
Metric
Orifice
Meter

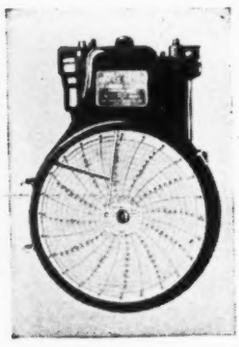


NATURAL GAS · MANUFACTURED GAS
NATURAL GASOLINE · PETROLEUM

DEPENDABILITY is not Accidental

SINCE 1915, when the first Westcott Orifice Meter was installed by Metric, this name has stood for dependability. In large stations, under close supervision or out in exposed and remote locations — the result has always been the same.

Dependability is not an accidental quality. A large float area, with a long lever arm; a small angle of pen arm movement and complete simplicity are the main reasons for this record. In the Modern Metric Meter the stuffing box is now made of hardened stainless steel and has a stainless steel bushing and is filled with grease to prevent even the slightest leakage. There is but one moveable joint from the float to the chart record.



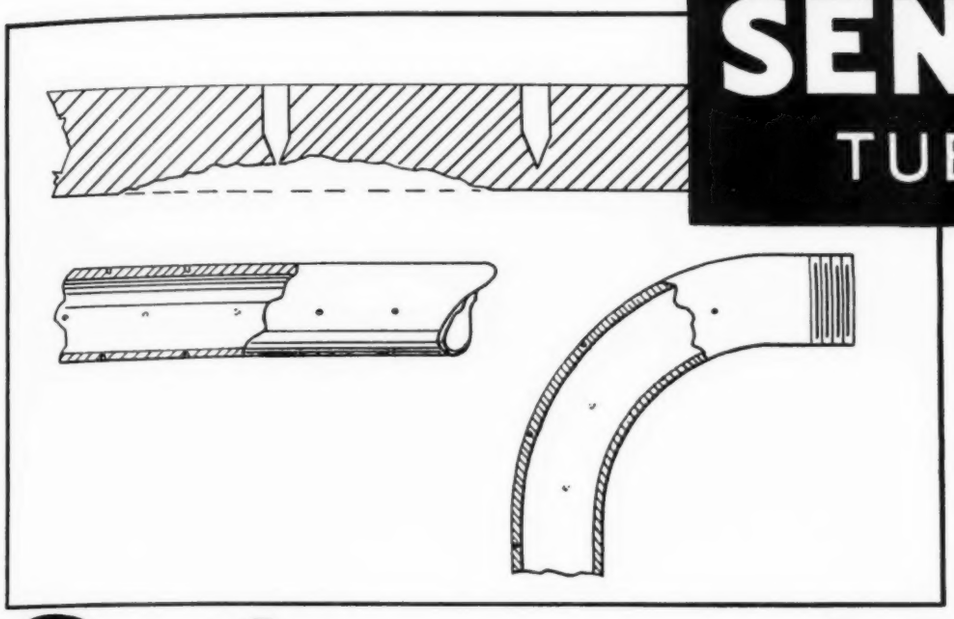
Ask for Bulletins E-2, E-3 and E-16, which describe Metric Orifice Meters, Metric Indicating Flowmeters and Metric Integrating Orifice Meters respectively. From these and from past and present installations you may see for yourself why these meters have led in dependability over such a long term of years.

AMERICAN METER COMPANY
INCORPORATED
ESTABLISHED 1836
METRIC METAL WORKS *ERIE, PENNSYLVANIA*
New York Philadelphia Erie Chicago Dallas Tulsa
Los Angeles San Francisco and other cities

METRIC METERS
AMERICAN METER CO
MEASUREMENT ENGINEERS
CUBIC FEET

2158

NATIONAL
SENTRY
TUBING



Safeguards
high pressure equipment

NATIONAL Sentry Tubing answers a very definite demand of refinery engineers. This demand is for pipe and tubes which when installed in and around a pressure still will not be subject to unexpected and dangerous failures due to internal corrosion or wear. When the walls of NATIONAL Sentry Tubing are thinned by either erosion or corrosion from within, a tiny leak will appear through a small hole drilled part way through the pipe or tube wall especially for this purpose. This hole is cone-shaped at the bottom, and as the wall is gradually eaten away, the hole grows larger and the leak becomes plainly noticeable, indicating that the metal has been worn at this point. Experiments carried on by refinery engineers in the field, demonstrated the soundness of the method involved, but drilling into equipment in actual use, at a sufficient number of points, at proper intervals, and with proper control of depth, was too burdensome and costly. NATIONAL Sentry Tubing is pre-drilled under a technique that is definite and embodies all that has been found most satisfactory in pipe and tubes for such use. Actual bursting tests show that this drilling does not impair the strength of the pipe and tubes.

NATIONAL Sentry Tubing is a seamless product made in a wide range of diameters and wall-thicknesses and in various grades of steel. Correspondence is invited from those who are interested.

NATIONAL TUBE COMPANY
Frick Building, Pittsburgh, Pa.

SUBSIDIARY OF UNITED STATES STEEL CORPORATION

PRINCIPAL SUBSIDIARY MANUFACTURING COMPANIES

AMERICAN BRIDGE COMPANY
AMERICAN SHEET AND TIN PLATE COMPANY
AMERICAN STEEL AND WIRE COMPANY
CARNEGIE STEEL COMPANY
COLUMBIA STEEL COMPANY
CYCLONE FENCE COMPANY
FEDERAL SHIPBUILDING AND DRY DOCK COMPANY
ILLINOIS STEEL COMPANY
NATIONAL TUBE COMPANY
OIL WELL SUPPLY COMPANY
THE LORAIN STEEL COMPANY
TENNESSEE COAL, IRON & R. R. COMPANY
UNIVERSAL ATLAS CEMENT COMPANY

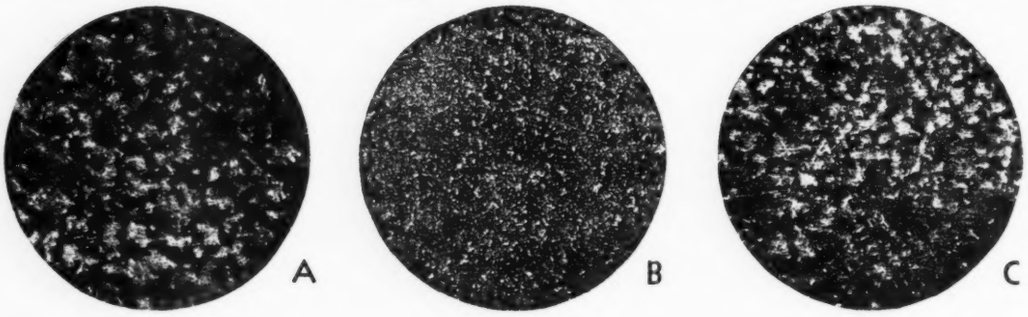
Pacific Coast Distributors—Columbia Steel Company, Ross Building, San Francisco, Calif. *Export Distributors*—United States Steel Products Company, 30 Church Street, New York, N. Y.

PRODUCTS
B S & B
SERVICE

Shop Talk

That Talks Back for Your Benefit

Hobnobbing with Molecules



THIS organization takes every precaution to assure the greatest amount of strength for its welded products, for with strength is combined usefulness and safety. We are not content with the most up-to-date equipment—mammoth annealing oven, new processes of welding, tensile tests, and the usual hydrostatic tests—we want to study the granular structure of steel and be sure of the plate metal, the weld metal, and the blend of the two. The only way we can be positive is through photomicrographs, which proves to us the exact condition of the metals and convinces us that the B. S. & B. Flexweld is as uniform as the parent metal itself.

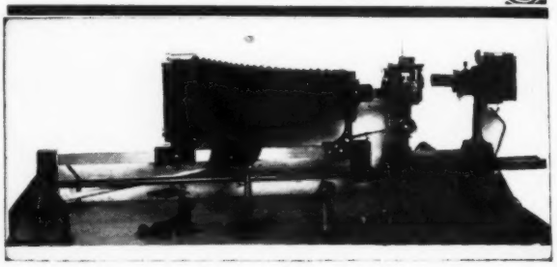
So, we resort to microscopic photographs, produced by special apparatus. Photomicrograph "A" shows typical plate metal; "B" indicates B. S. & B. Flexweld weld metal; and "C" the fusion zone between the two. Note the structure of the weld metal, so finely grained, without voids, and without trace of oxides, slag inclusions, or nitrides. Note, too, how the two metals have blended, forming a uniform bond between the two.

Insuring "The Weld that Held"

THESE tests are made periodically, to be sure that the weld metal is lacking in porosity, free from oxides and other inclusions, and is strong and ductile. B. S. & B. Flexweld metal is as strong, if not stronger, than the parent metal. It resists corrosion, and assures flexibility and strength. The weld equals the plate itself in tensile strength, shock resistance, ductility, and ability to withstand repeated stresses.

B. S. & B. Flexwelding is an exclusive process developed by us, giving a uniform texture of welding. It is accomplished by automatic welding equipment, and a shield arc process.

B. S. & B. Flexweld complies with the Boiler Code requirements of the A. S. M. E. Each B. S. & B. Flexweld is ductile, and under bend test the minimum elongation is more than 30%. B. S. & B. Flexwelded vessels are safe!



THIS is a photograph of our photomicrograph machine in our metallography laboratory. By this machine, our skilled engineers may study the granular structure of the steel used in our plant, and can reject any defective material. The grain structure of the metal is most important, and this factor has not been overlooked in the B. S. & B. organization.

BLACK, SIVALLS & BRYSON
INC.
OKLAHOMA CITY, OKLA.
AMERICAN TANK & EQUIPMENT CORP.
MANUFACTURING SUBSIDIARY – OKLAHOMA CITY, OKLA

We'll gladly explain the more technical phases of these tests, as carried out on every job. You are invited to witness such tests at our plant. Let us figure on your needs for pressure vessels, refinery, and other welded equipment. Our engineers will cooperate with you.

TRANSIT HOLLOW BALL VALVES } Will Increase the Capacity of your Pipeline Pumps

Use them to replace Solid Balls

See that your suction valves are light and lift easily.

Then you can expect to pump a cylinder full of oil each stroke, even when pumping East Texas crude.

Light valves reduce the pull on the column of oil, and cut down the tendency of the oil and gas to separate.

And remember, you get paid for pumping oil—not gas.

By "LIGHT VALVES", we mean TRANSIT Hollow Ball Valves.

They are hollow, light weight, seamless, balanced, extremely accurate, and contain no plugs to loosen and leak.

Carbon or stainless steel, 1 to 8 inches in diameter. Both types heat treated to give a tough metal structure throughout, together with a hard surface.

A call from you will bring one of our engineers to discuss the advantages of using these valves.

Fig. 2253—They are Tested for balance by Floating in Mercury

REFINERY PUMPS
FOR HOT OIL
And every other refinery service
TRANSIT (Cross) ROTARY PUMPS
PIPE LINE PUMPS

PHOENIX, ARIZ. Pratt-Gilbert Co.
SALT LAKE CITY, UTAH F. C. Richmond Machinery Co.

NATIONAL TRANSIT
PUMP & MACHINE CO.
OIL CITY, PA.

LOS ANGELES Republic Supply Company of California
ST. LOUIS, MO. Reeves & Skinner Machinery Co.

New York Chicago Cleveland Pittsburgh Los Angeles Houston Tulsa

FIELD PUMPS
TOOLS
for Pipe Line Construction
GAS ENGINES
GAS ENGINE GAS COMPRESSORS

There is no

MYSTERY

in Sucker Rods

Any particular steel analysis plus the same manufacturing practice—plus the same well practice—*must* give the *same* results.

BETTER STEEL—such as Jones High Manganese, plus—BETTER manufacturing practice, such as *Fully Normalizing—will* give BETTER results.

No single steel analysis is suitable for *all* well pumping conditions.

Sucker Rods should be purchased on chemical and physical specifications to meet varying conditions.

Jones Sucker Rods can be furnished in analyses to meet all conditions and all Jones Sucker Rods are completely normalized from end to end—insuring absolute uniformity.

As to price—if you compare prices with *specifications*—we know you will buy Jones Sucker Rods.

THE S. M. JONES CO.

TOLEDO, OHIO

25 BROADWAY, NEW YORK CITY
McBIRNEY BLDG., TULSA, OKLA.

"Sorry Chief . . .

. . . production's off this morning. We had to shut down everything on account of our water wells going hay-wire again. Must be quicksand. Our water wells just won't get the job done; what we need is a WATER MINE that will produce millions of Gallons where we're only getting a few thousand Gallons now. Think it over, Chief. . . .

OR WRITE THE WATER MINING CORPORATION FOR FURTHER DETAILS

Water Producers for the Petroleum Industry

The Water Mining Corporation

26 Broadway, New York

Kennedy Building, Tulsa, Oklahoma

PERFECT PERFORMANCE

. . . . of American Iron Products scores again . . . . this time in our great Oil and Gas producing state — Texas

From Kilgore in East Texas to Big Spring in the broad plains of the western part of the State; from Red River to the Gulf Coast, American Iron's Producing, Fishing and Drilling Tools have been doing the job right.

●

These and other American Iron Products, because of their dependability, have played an important part in developing the great Texas fields.

●

AMERICAN SHOT BARREL
(Formerly known as Fitz Shot Barrel)
Extensively used in Pettus, Big Spring and many Gulf Coast Fields.

●

AMERICAN FLOW PACKER
(Formerly known as Fitz Packer)
Largely used in East Texas, Rio Grande City and Wichita Falls Area.

●

RELEASING AND CIRCULATING SPEAR
Used and preferred in all Texas Fields.

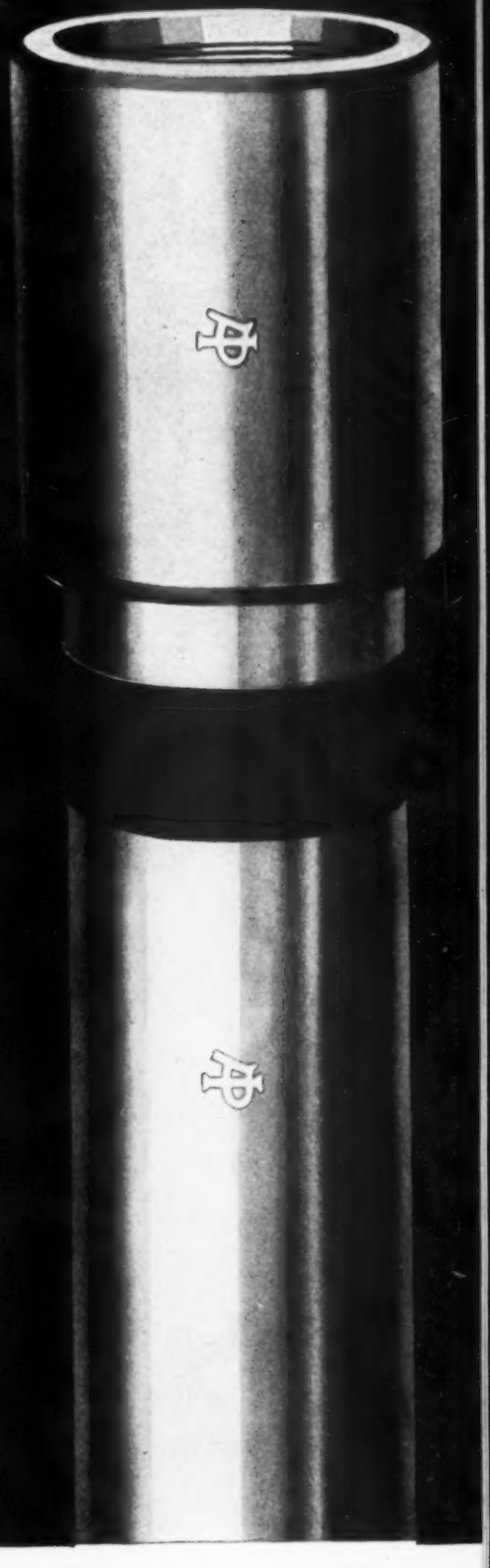
Releasing and Circulating Spear | American Flow Packer | Shot Packed Barrel

AMERICAN IRON & MACHINE WORKS CO.

Kilgore, Texas | OKLAHOMA CITY, Oklahoma | Joinerville, Texas

MANUFACTURERS OF OIL FIELD EQUIPMENT

STRAIGHT

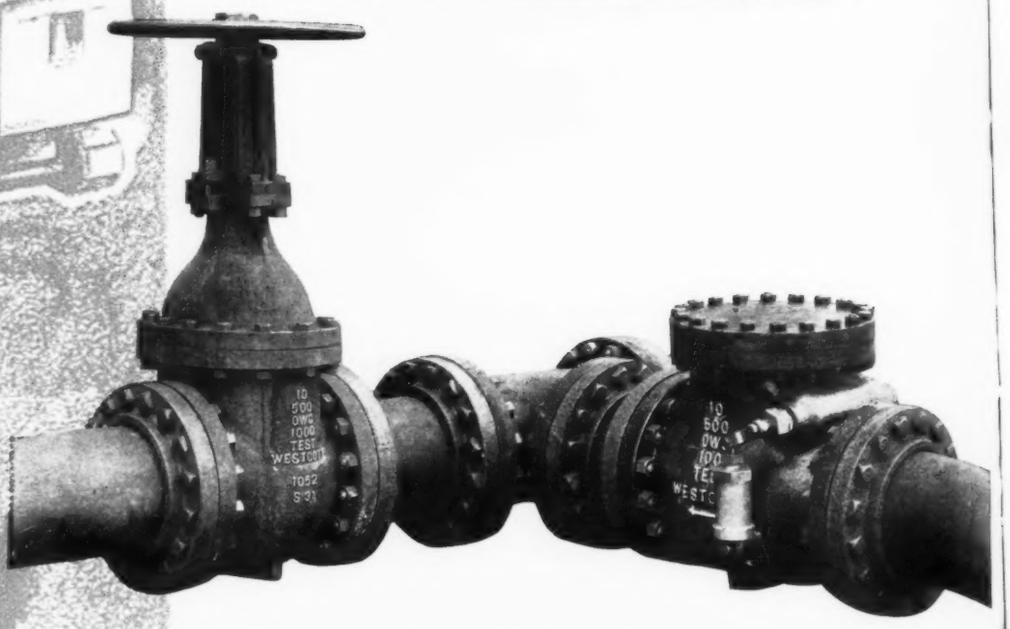


YOUNGSTOWN

OIL COUNTRY TUBULAR GOODS

FOR THE LIFE OF THE LINE

WESTCOTT
SEMI-STEEL
VALVES



Westcott Gate Valves, Fittings and Check Valves for pipe line service have become standard on many of the largest gas lines because of their record of proven performance.

The dash pot operated check is quiet in operation and long lived, simple in adjustment to varying surges and operating pressures.

"If Continental Sells it . . . There is no Better"

THE CONTINENTAL SUPPLY COMPANY

General Offices: ST. LOUIS

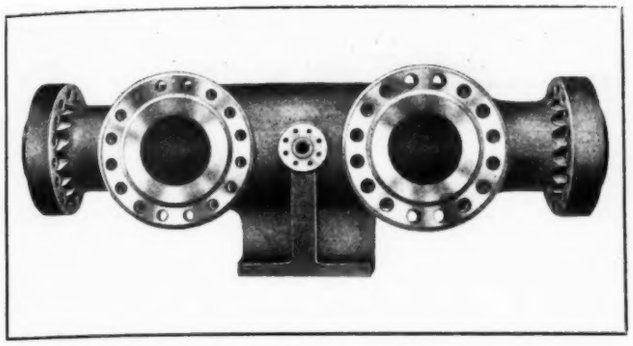
THE CONTINENTAL SUPPLY CO., LTD., 224 Traders Bldg., Calgary, Alberta, Can.
Export Offices: CONTINENTAL EMSCO CO., Inc., 19 Rector Street, New York
London Offices: 316-17 Dashwood House, Old Broad St., E. C. 2
CONTINENTAL EMSCO S.A.R. Strada Marfurilor, Ploesti, Romania

CONTINENTAL

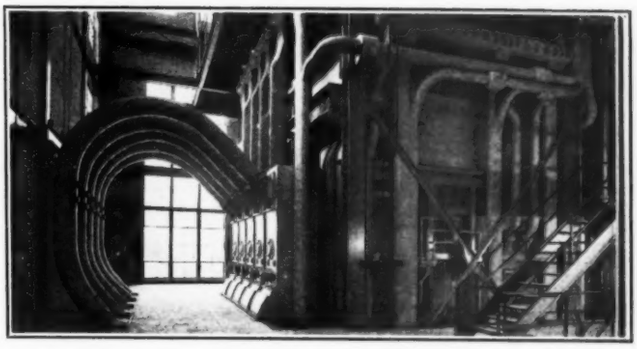
CONSULT

PITTSBURGH PIPING & EQUIPMENT COMPANY

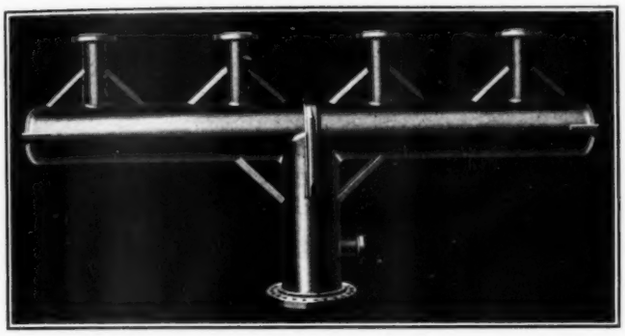
CONCERNING YOUR PIPING PROBLEMS



12" - 1350 lb. Cast Steel Manifold, Flanges with SARLUN facings. Made for large industrial power plant.



Accuracy and efficiency are characteristic of every Pittsburgh Piping installation.



20" O. D. 250 lb. Welded Header, 16 feet long, with 1-20" and 5-8" welded necks to be installed in gas line.

36" Cast Iron Multiport Check Valve for use in large steel plant.

Twenty-nine years' experience manufacturing and installing piping materials in power stations, oil refineries and industrial plants enables Pittsburgh Piping & Equipment Company to meet your specific requirements with foresight and knowledge.

Constant development of our facilities through research and service guarantees purchasers of Pittsburgh Piping products better workmanship and materials.

PITTSBURGH PIPING AND EQUIPMENT CO.

43RD ST. & A.V.R.R. PITTSBURGH, PA.

P&E Co.

BRANCH OFFICES

Indianapolis — New York
San Francisco — Chicago
Cleveland — Detroit
Houghton, Mich. — Boston

RUNNING TOUR With Men In The Industry

W. C. Price

W. C. Price, district foreman, Humble Pipe Line Company, has been transferred from Mineola, Texas, to Van.

John A. Grant, Stanolind Oil & Gas Company, has moved from Longview, Texas, to Saginaw, Mich. He is main line foreman in the pipe line division.

S. W. Emery, division superintendent, The Carter Oil Company, Duncan, Okla., has been transferred to the Seminole district and is making Shawnee his home.

Kenneth A. Covell, chief petroleum engineer for the Indian Territory Illuminating Oil Company, has been transferred to the company's Oklahoma City office. Mr. Covell has heretofore made Bartlesville his headquarters.

John W. Schaffner, Imperial Belting Company, has moved from Oak Park, Ill., to Kansas City, Mo.

Arthur Webb, farm boss, Shell Petroleum Corporation, formerly located at Marshall, Okla., is now at Snomac, Okla.

Kenneth A. Covell

I. D. Wilson, station engineer for the Kansas Pipe Line Company, has been moved from the company's station at Medicine Lodge, Kansas, to McPherson, Kansas.

Gilbert Wood, formerly general manager of the Pennsylvania Power & Light Company, at Wellsboro, Pa., is now with the Argus Production Company at Hugoton, Kansas.

C. E. Murray, chief engineer of main line stations, Humble Pipe Line Company, has moved from Pampa to Borger, Texas.

M. H. Haynes, technical engineer, Empire Oil & Refining Company, has been transferred from Arkansas City, Kansas, to Seminole, Okla.

Harrison J. Behr, sales promotion manager, Boston Woven Hose & Rubber Co., Cambridge, Mass., is visiting the oil fields west of the Mississippi River on a trip which will take him to the Pacific Coast territory.

W. A. Hazard, division production superintendent, Oklahoma Natural Gas Corporation, has been moved to Tulsa from Chickasha, Okla.

William J. McKee, formerly sales agent for the National Tube Company at Tulsa, has been promoted to assistant manager of sales and will make his headquarters in New York City. Earle E. Smith, previously field engineer at Fort Worth for the company, has been appointed sales agent at Tulsa (under jurisdiction of the St. Louis office) to succeed Mr. McKee. E. L. Wycoff, who has been an engineer in the field department, with headquarters at Tulsa, has been made field engineer and been transferred to Fort Worth. These changes became effective September 1.

William J. McKee

E. C. Willard, refinery superintendent for the East Texas Refining Company, has moved his residence from Henderson, Texas, to Longview, Texas.

H. L. Blagg, inspection engineer, production department, The Texas Company, has been transferred from Mont Belvieu, Texas, to Houston, Texas.

Robert M. Hess, production treating engineer, Shell Petroleum Corporation, previously located at Cushing, Oklahoma, has been transferred to Tulsa.

J. A. O'Brien, division production superintendent, The Carter Oil Company, has been transferred from Ponca City, Oklahoma, to Duncan, Oklahoma.

Harold A. Sanders, production field foreman, Sun Oil Company, formerly located at Woodsboro, Texas, has been transferred to Arp, Texas, in the East Texas field.

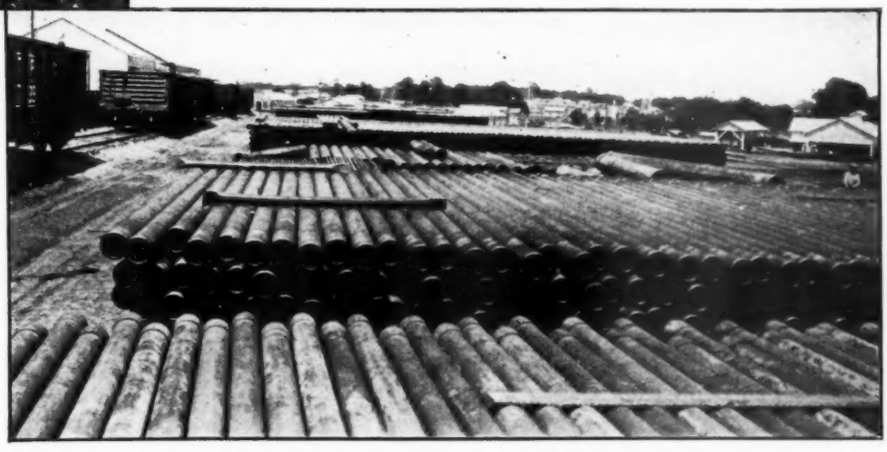
E. L. Holloway, district production superintendent, Sinclair-Prairie Oil Company, has been transferred from Seminole, Oklahoma, to McPherson, Kansas.

W. C. Trout is on an extended business trip to the North and East in the interest of the Lufkin Foundry & Machine Company, of which he is president. Mr. Trout expects to return to Lufkin about the middle of September.

H. R. Gershman, production foreman, and L. Mize, chief gauger of oil lines for the Heep Oil Company, have been transferred from Kilgore, Texas, to Conroe, Texas, where the company is developing some important new production.

A view of one of many wells being drilled in which "Chester" casing is being used, giving satisfactory and efficient service.

View of stock of "Chester" casing carried by one of the various oil companies for future use.



Care of manufacture and material used have contributed to its success.

Chester also makes all classes of Genuine Wrought Iron Line Pipe and Copper Bearing Steel Pipe.

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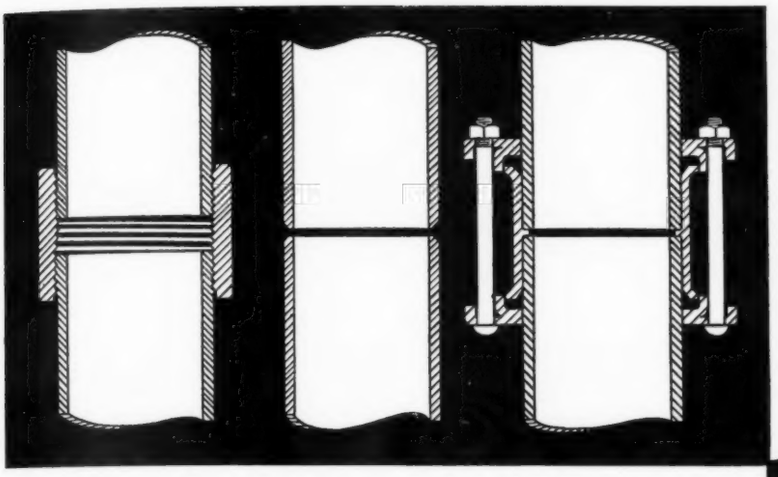

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EVERY pipe line engineer has his own preference for what he believes to be the best type of joint for each particular kind of line. His hardest job is to find the kind of pipe that works best with that type of joint. That's why there is a satisfaction in knowing that Republic Electric Weld Pipe is fine for every type of joint.

Perfect roundness, uniform thickness of wall, freedom from surface markings and projections, and straightness —these are the qualities of Republic Electric Weld Pipe that should influence its selection when joints are under consideration.

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Another point worth remembering is that Republic Electric Weld Pipe can be supplied in lengths up to fifty feet, making far fewer joints necessary in the line. All sizes up to 16 inch O. D.

Write for Catalog 210-B, giving full engineering data and other facts about this remarkable pipe.

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"We have used the SYFO in East Texas with Excellent Success and now consider it as a regular part of our drilling equipment"

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MOST Texas factories have gone modern . . . and smoke stacks are now relics of the past.

Industry has adopted NATURAL GAS . . . a better, more efficient all-around fuel that burns clean . . . and dispells the bugaboo of delayed production.

Natural Gas has more than 60,000 uses in industry . . . ranging all the way from producing intense heat to the manufacture of dry-ice.

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No other fuel is so easily adapted to do ANY job . . . no other fuel is so clean . . . no other heat is so swift in operation and so easily controlled.

That's our idea of fuel efficiency!

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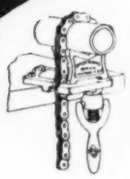
CHAIN TONGS

Jaws drop forged from special steel, heat treated, hardened, tempered and tested. *Handles* forged from high carbon steel have both stiffness and "spring." *Chains* have proven strength—are proof-tested to 2/3 catalog strength (3,600 to 40,000 lbs.). *Design improvements:* jaws have increased bearing on bar and forged-in chain guides, large steel bolt, drop forged shackle.

Write for Cat. P-10



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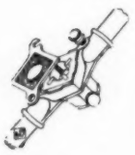

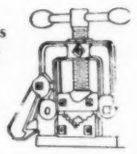

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NEW 6-DAY RENTAL MINIMUM

Means Big Savings to Oil Operators

Reductions of 35% to 50% on Most Tools

Save Real Money on your Rental needs by using Bridgeport's new 6-day Rental Minimum. This applies to all rental tools with the exception of Swan Underreamers (on which the minimum is still 10 days), and complete strings of cleaning out tools (on which the minimum is 14 days.)

HERE ARE REAL SAVINGS

Study these new low rental prices carefully. They will save you Real Money.

	New 6-day Price
6⅝" Hychrome Combination Socket	$ 9.25
6⅝" Bridgeport one-piece Hollow Reamer	9.00
20" Drive Head	21.15
6⅝" Elevator, with links	3.50
Complete strings of cleaning out tools for 5 3/16" hole	100.00 for 14 days
Complete strings of cleaning out tools for 6⅝" hole	120.00 for 14 days

(Boilers, engines, casing and pipe not included with above.)

50% REDUCTION

ON UNDERREAMER RENTALS

Regular type Swan Underreamer rentals have also been cut a straight 50 per cent. This means that you can now rent a Regular Type Swan for just half what it formerly cost you—on the same 10-day minimum, with either plain or hard-face cutters. Rates for additional days also reduced 50 per cent. A regular charge, of course, is made for hard-face cutters.

In addition to the above, an extra allowance of $25.00 is offered if the rental outfit is returned within 3 days, and only one set of regular cutters used.

Hard-face cutters can now also be rented for the New Type Swan, ready to run without field dressing—subject to a nominal charge for re-hard-facing used cutters.

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Branches Conveniently Located in All Active Mid-Continent Oil Fields

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in every GASO Pump is dependable because of proper design. In GASO Fig. 1508 Pump, shown below, every moving part is provided with a flood of clean oil at all times. This automatic, thorough lubrication promotes long life, low maintenance cost and minimum consumption of power, and makes these pumps ideal for installation in remote places where frequent attention is difficult and expensive. . . . . .

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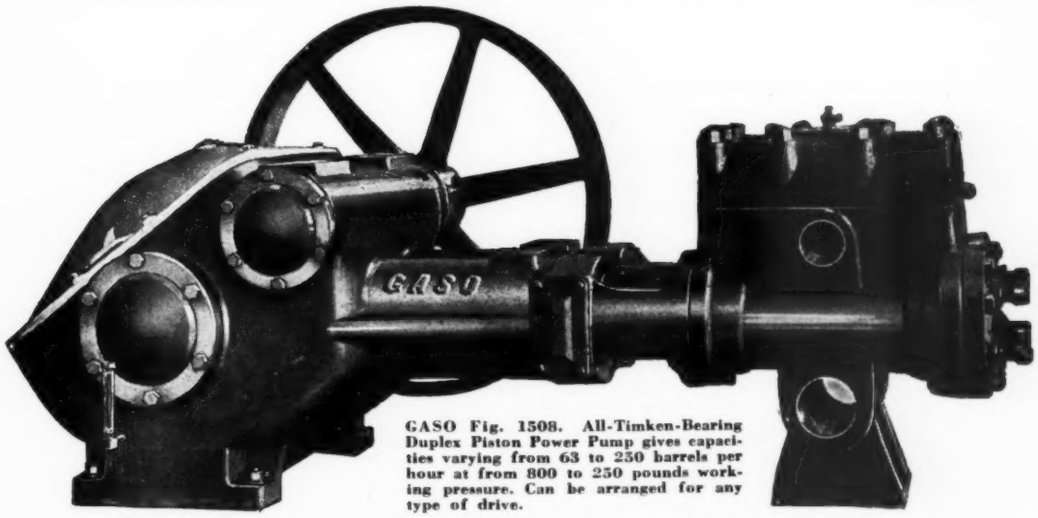

GASO Fig. 1508. All-Timken-Bearing Duplex Piston Power Pump gives capacities varying from 63 to 230 barrels per hour at from 800 to 250 pounds working pressure. Can be arranged for any type of drive.

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